DESCRIPTIVE ANATOMY.

MANUAL

OF

DESCRIPTIVE

AND

PATHOLOGICAL ANATOMY,

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TRANSLATED FROM THE GERMAN INTO FRENCH,
WITH ADDITIONS AND NOTES,

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WITH NOTES,

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IN TWO VOLUMES.

VOL. I.

LONDON:
G. HENDERSON, OLD BAILEY;
FANNIN AND CO., DUBLIN; CARFRAE AND SON, EDINBURGH.

1839.

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DESCRIPTIVE ANATOMY.

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II. ABNORMAL STATE.

A complete work, exhibiting even generally all deviations of the external form and of the texture of the whole and of the parts of the human body, is still wanting, although we have excellent figures of the most abnormal deviations.

We find a considerable number of the different anomalies figured in Baillie, *A series of engravings accompanied with explanations, which are intended to illust. the morbid anat. of some of the most imp. parts of the hum. body*, London, 1799.

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DESCRIPTIVE ANATOMY.

§ 457. *Descriptive anatomy*, or the *topography* of the human body, is the exact description of the parts which constitute it. It considers,

1st. The human body generally, and its different regions, without regard to the difference of the systems composing it; it points out the dimensions of the whole body and those of its parts, and also the mutual relations of these parts.

2nd. The different systems which compose it, in respect to the situation, the number, the size, and the forms of its parts.

DESCRIPTIVE ANATOMY.

PART I.

GENERAL REMARKS ON THE HUMAN BODY.

§ 459. We have already stated the special characters of the human body: it only remains to examine—

1st. Its height.

2nd. Its divisions into different regions.

§ 460. The *height* of man is not the same every where. Like that of all other organic formations, it depends in some measure on the climate: hence the tallest men are found in the warmest countries, while the shortest inhabit the colder regions. In considering the normal differences which belong to whole masses, we find the height varies from six feet and a half to four feet and a half, so that the mean is between five and six feet; that the male is a little taller than the female; and that we may consider as untrue all assertions that nations exist in which the height generally exceeds, or is less than these limits. But, although all nations present a certain fixed height, when considered generally and in the mass, individuals differ much in this respect, sometimes exceeding the common measure, and sometimes falling short of it. If we take individuals into consideration, we find the height of man varies from eight feet to sixteen inches.*

In both cases the relations between the different parts of the body deviate usually from the ordinary rule. Generally the lower extremities of *giants* are very short; the superior, on the contrary, are very long: the head also is too small. In almost all *dwarfs*, the head is too large; but the relation between the upper and lower extremities is the same as in giants. The cause of dwarfishness is general disease, especially rachitis.

Besides those cases in which we see certain individuals taller than the rest of the species, it sometimes happens that the body prematurely acquires all the development in regard to height of which it is susceptible. This state, which is characterized also by the precocious appearance of puberty, is almost always attended with a proportional

* Haller, in his Physiology, mentions several giants and dwarfs.—Bonn (*Thes. morb. oss. Hov.*, Amsterdam, 1783, p. 134—136) has given the dimensions of the skeletons of giants.—Zitterland, *De dourum seelectorum praegrandium rationibus*, Berlin, 1814.—The accounts of men more than eight feet in height are doubtful, or arrive from considering fossil bones of large animals as human bones, or finally depend upon the extraordinary development of the crania from hydrocephalus.

imperfection in the development of the intellectual faculties, and a very short life.

§ 461. The human body is composed, *a*, of a right and a left, an upper and a lower, and finally of an anterior and posterior half: we have already mentioned their principal characters (§23—28) in respect to the analogies and discrepancies. *b*. It is also divided into three parts, the *trunk* (*truncus*), the *head* (*caput*), and the *limbs* (*extremitates*). These are also subdivided into several regions.

§ 462. The *trunk* (*truncus*) comprises three parts: the *neck* (*collum*), the *chest* (*pectus*, *thorax*), and the *belly* (*abdomen*). Each of these parts is composed of some one of the different organic systems. The chest and the belly are hollow, and their *cavities* (*cava*) experience greater or less changes in their figure and their dimensions. These cavities contain organs, which in the normal state do not adhere to their parietes, except anteriorly and posteriorly, but are in close contact with them, and are called for this reason the *viscera of the chest*, *of the abdomen*, and *of the pelvis*. The neck has no cavity: the parts which form it are united together, and with the skin which covers them all, by mucous tissue, while in the thorax and the abdomen, the skin and the bones, as well as the muscles directly united to the integuments, are separated from the subjacent parts by a proper serous membrane.

The vertebral column forms the base of the whole trunk. It is a hollow column composed of bones placed one upon another; these bones have the same general form, but this form is differently modified in the different regions. It extends from above downward, in the centre of the posterior face of the trunk, and is covered its whole length backward and on both sides, also forward in the neck and in the upper part of the abdomen, by muscles which move the vertebral column and the parts attached to it, the head and the limbs, and finally the organs contained in the cavities.

The parietes of the abdominal cavity, except the middle of its posterior face, are formed at their upper part, which is the most extensive, of several superimposed layers of muscles, most of which are broad and flat, called the abdominal muscles; and it is in this direction also that its dimensions and form vary the most. Its lower portion, on the contrary, the *pelvis*, admits of the least motion, because it is principally composed of firmly articulated bones, viz. the sacrum, a fusion of broad vertebræ, and the coxal bones, which unite with it backward, and with each other forward. The pelvis is also the narrowest visceral cavity of the trunk, and the narrower and more manifold connections of the organs it contains with its parietes, cause it in some measure to resemble the neck.

The parietes of the thoracic cavity, except the lower, which separates it from the abdominal cavity, and is formed by a broad muscle, the *diaphragm*, are composed of the ribs, which are moveable, lateral prolongations of that portion of the spine which makes its base, of the sternum which corresponds to the vertebral column forward, and of the muscles situated upon, under, and between the ribs. Hence its

parietes, though moveable, are not susceptible of such great changes in their dimensions as the abdominal parietes; its form is more constant, and normally depends upon these parietes, while that of the abdomen depends upon the parts contained in its cavity.

Finally, the *neck* is the narrowest and shortest portion of the trunk. The latter enlarges gradually from the neck to the lower part of the chest and the upper portion of the abdomen; but after leaving this point, it gradually contracts to its extremity, and terminates by a very narrow opening, which is susceptible of enlarging, from the mobility of the bones attached to the extremities of the vertebral column.

§ 463. The outer surface of the divisions of the trunk which we have mentioned is itself divided into several regions. In this respect we may imagine the abdomen divided into three parts, situated above each other, by two transverse lines which partially or wholly encircle it.

Of these two lines, the upper passes over the lower ribs, and the lower over the summit of the coxal bones. We have now three compartments: the first above the upper line, the second between this and the lower, and the third below the lower line: these also are divided into several regions by almost perpendicular lines.

The upper is called the *epigastric region* (*regia epigastrica*). It does not include the entire circumference of the body, but only its anterior and its lateral faces. Its form is triangular, and it is composed of four other regions, two lateral and two middle regions. The right and left lateral regions are called the *hypochondriac regions* (*R. hypochondriacæ, hypochondria*). They are bounded above by the anterior edge of the cartilages of the five false ribs, below by the upper transverse line, and within by the upper part of the two anterior perpendicular lines.

The two middle regions are situated one above the other. The inferior, which is the most extensive, is called the *epigastrium* (*R. gastrica*, s. *epigastrica stricte sic dicta*); the smaller, situated below the inferior extremity of the sternum, the *cardiac* or the *præcordial region* (*scrobiculus cordis*, s. *regio cardiaca*).

The middle region is termed the *mesogastric*, or the *umbilical* (*R. umbilicalis*, s. *mesogastrica*). It surrounds the centre of the whole abdomen, like a girdle, and is divided by perpendicular lines into five other regions placed at the side of each other.

The *umbilical region* (*R. umbilicalis*) forms the centre, and is so called because the umbilicus is in it. Those next to it, which comprise the external part of the anterior face and the anterior part of the lateral faces, are the *iliac regions* (*R. iliacæ*). Finally, the posterior parts, which run into each other in the centre of the posterior wall, are called the *lumbar regions* (*R. lumbares*).

The inferior region is termed the *hypogastric region* (*R. hypogastrica*). It comprises the upper but only the anterior part of the abdomen, and is formed of three other regions, the central, the proper *hypogastric region* (*R. hypogastrica stricte sic dicta*), extending from the upper boundary of this region to the pubis, to the anterior edge of the

pelvis; and the two lateral, the *inguinal regions* (*R. inguinales,*) which are situated between the preceding and the iliac bones.

At the lower part of the abdomen, or at the pelvis, we distinguish, forward, the *pubic region* (*R. pubis*), which includes the external organs of generation, and is continuous below with the *mons veneris;* backward and downward, below the pubes, between them, the anus and the thighs, the *perinæum* (*perinæum* s. *interfeminæum*); and finally, backward, the *nates.*

§ 464. The chest is divided forward, on the sides and upward, into three *mammary regions* (*R. mamillares,*) backward, into the *scapular regions* (*R. scapulares*). In the neck also we distinguish forward and downward, the *throat* (*jugulum*); backward, the *nape* (*cervix* s. *nucha*).

§ 465. The *head,* the bulging upper extremity of the trunk, is generally round. It cannot in most of its extent change its form, because its foundation is a bony case, all the parts of which, except the lower maxillary bone, are immoveably articulated. It is divided very naturally into two parts, the *skull* (*cranium*), and the *face* (*facies*), the former composed of the brain, the walls of the cavity which contain it, and of the organ of hearing; the latter, of the organ of sight, of smell, of taste, and of mastication.

The *skull* occupies the upper and posterior part of the head and is round. The *face* is situated downward and forward, and is irregularly quadrilateral. The skull is always much larger than the face.

We distinguish in the skull, a lower part or *base* (*basis*), two *lateral faces,* an anterior or *temporal region* (*R. temporalis, tempora*), and a posterior or *auricular region* (*R. auricularis*), an *anterior face* comprising, an anterior region, the *forehead* (*R. frontalis*), of which the middle and lower part is termed the *glabella,* and the upper region is called the *sincipital* or *sinciput* (*R. sincipitalis* s. *sinciput*); finally, an upper face, the *top* of the head and of the whole body, called the *vertex,* and a *posterior* or *occipital region,* called the *occiput* (*R. occipitalis* s. *occiput*).

The face comprises the *region of the nose* (*R. nasalis*), that *of the mouth* (*R. oralis*), and the region *of the chin* (*mentum*), which are placed above each other on the median line, and also two other lateral regions, of which the upper, called the *cheeks* (*genæ, regio jugalis*), comprises almost all the breadth of the face, and the projection caused by the malar bones, while the lower, placed at the two sides of the mouth, and called the *buccal region* (*R. buccalis*), forms the parietes of the *buccal cavity* (*cavum oris*).

The three great cavities of the body, the cavity of the skull, of the chest, and of the abdomen, are also known by the common name of *splanchnic cavities* (*cava,* s. *ventres*). In each is situated one or several of the organs necessary to the preservation of the individual or of the species. The abdomen contains the most essential parts of the digestive apparatus; and the genital organs are situated within it, and in the lower part of its circumference, the pelvis. The heart, and the organs of respiration, are placed in the chest; the vocal apparatus in

the neck; and the brain, and the most noble organs of sense in the head.

§ 466. The *members, limbs* (*membra*) are distinguished into the *upper* and the *lower*, or the *pectoral*, the *thoracic*, the *abdominal*, and the *pelvic*. They are long, composed of several sections which move upon, and are placed after each other in the trunk, and are articulated so as to perform motions as a whole or as different parts. They are formed essentially of bones, which occupy their centre; of muscles and of tendons, which cover the different bones and direct their motions; of fibrous and of synovial ligaments, which unite the bones together; of nerves, of vessels; of the skin, which covers all these parts, and of cellular tissue which unites them as a whole, and at the same time separates them from each other. The parts composing the limbs become smaller and more feeble, as the distance from the trunk increases; but all the systems which compose them unite in the same proportion, so that their motions also are more extensive. Farther, the upper and the lower limbs correspond perfectly, not only in the number and the volume of their dimensions, but in the general arrangement of their different systems.

The parts of the upper limbs, after leaving the trunk, are—

1st. The *shoulder*, the under part of which is indented, and is termed the *arm-pit* (*fovea axillaris*).

2d. Of the *arm* (*brachium*).

3d. Of the *elbow* (*cubitus*), the union of the arm with the next portion.

4th. Of the *fore-arm* (*anti-brachium*).

5th. Of the *hand* (*manus*).

The hand is divided into three parts, the upper, the shortest, which is called the *wrist* (*carpus*), the middle, the *metacarpus*, and the anterior, which is the longest, and is composed of the *fingers* (*digiti*). Each finger comprises three divisions, termed *phalanges;* the *thumb* (*pollex*), however, has only two.

We distinguish in the arm four faces, the *external* (*regio* s. *facies externa*, s. *extensoria*), the *internal* (*regio* s. *facies interna*, s. *flexoria*), the *anterior* (*regio* s. *facies anterior*, s. *abductoria*), and the *posterior* (*regio* s. *facies posterior*, s. *abductoria*); in the fore-arm, only two, the *external*, and the *internal;* four in the hand, the *anterior* or the *radial* (*margo anterior*, s. *radialis*), the *posterior* or *ulnar* (*margo posterior*, s. *cubitalis*), the *external* or the *upper*, called also the *back of the hand* (*facies externa*, s. *superior*, s. *dorsum*), and the *internal* or *inferior*, called *the palm of the hand* (*facies interna*, s. *inferior*, s. *vola*).

The following are the divisions of the lower limbs:—

1st. The *thigh* (*femur*)

2d. The *knee* (*genu*), the articulation of the thigh with the leg, the under part being called the *ham* (*poples*, s. *fossa genu*).

3d. The *leg* (*crus*), its upper and posterior fleshy part being called the *calf* (*sura*).

4th. The *foot* (*pes*), which is sub-divided into the *tarsus*, the *me-*

tatarsus, and the *toes* (*digiti pedis*); these last are composed of *phalanges* arranged in the same manner as those of the fingers.

The inferior limbs are characterized by firmness and strength, and the superior by suppleness and mobility; the former serve to move and support the body, the latter to grasp external objects. The pelvic are usually much larger than the pectoral limbs; some of their parts, however, as the toes, are less developed and smaller than the fingers.

§467. The configuration of the body presents remarkable differences at different periods of life, in respect to the forms and sizes of its component parts.*

At first, the anterior and the posterior faces of the body are divided longitudinally on the median line.

In a full grown man, the length of the head is one seventh of that of the whole body, measured from the vertex to the toes, and the space between the extended arms almost equals this length.

At first, the head cannot be distinguished from the rest of the body; hence, it increases very much in size afterwards. The neck is not separate from the trunk. We see no trace of the limbs. These do not appear till the sixteenth week, and then as small stumps, the superior being larger than the inferior. In the adult, the pelvic members are some inches longer than the thoracic, but in the fœtus the pectoral are longer until the eight month, so that the want of proportion gradually diminishes. Until the age of five years, the four limbs have nearly the same length; but at this period, the inferior gradually lengthen, so that when fully developed, they are as long as the trunk and the head together.

In the early periods of existence, all the lower half of the body, in proportion to the upper, is generally much smaller than in the adult.

The abdomen projects considerably, not only from the greater development of the liver, but also because the smallness of the cavity of the pelvis does not allow the bladder and the internal organs of generation of the female to descend into the cavity of the pelvis.

The lumbar portion however is then much longer in proportion than in the adult, owing, no doubt, to the great size of the liver, as also to the slight development of the respiratory organs, and of the cavity of the chest, which is not only lower, but flatter.

The principal sexual differences are,† besides those already mentioned, the considerable size of the skull in relation to the face, and of the head in proportion to the rest of the body, the smaller size of the thoracic cavity, the greater uniform breadth of every part of the abdominal cavity in the female, while it is narrower upward, and broader downward, in man; the greater length, and finally, the capacity of the pelvis, which is much greater in every respect in the female.

* Sue, *Sur les proportions du squelette de l'homme, examiné depuis l'âge le plus tendre jusqu'à celui de vingt-cinq, soixante, et au-delà*, in the *Mém. présentés de Paris*, vol. ii. p. 372.

† Ackermann, *De discrimine sexuum præter genitalia*, Mayence, 1788.

From this it happens that when a man lies on his back, the anterior face of his chest projects above the symphisis pubis, which is not the case in the female.

§468. Such is the normal form of the human body; but it offers numerous anomalies, of which we shall briefly state those only which are primitive.

1st. *Of the Anomalies in quantity.*

A Imperfect development. This anomaly is greatest when the upper part of the body is deficient to a greater or less extent constituting *acephalia.**

This monstrosity can exist in an infinite number of degrees, from the existence of only one inferior limb to a slight defect in the formation of the bones of the skull, by which its cavity is imperfectly closed. It is divided into *true* and *false acephalia* (*A. vera et spuria*); the latter, however, should be called simply *acrania, anencephalia.* Sometimes more than the head is deficient in true acephalia. The reverse of the imperfect development of the skull is that of the face, distinguished principally by the union of the two eyes or of the two cavities of the nose, the smallness or absence of the lower jaw.

The reverse of the imperfect development of the upper part of the body is that of the lower part, consisting essentially in the union of the two legs into one, placed on the median line, at the same time being bent, so that its anterior face becomes posterior, and the posterior anterior.

Here we may remark generally, that the imperfect development of the lower portion of the body never exists to so great a degree as that of the upper part, which is probably owing to the laws of formation; for in birds, at least, the trunk seems to be formed from below, upward.

The imperfect development of the anterior and posterior faces of the body is shown by the want of union between the two lateral halves, and by the imperfect formation of the cavities by fissures; in the head, by the fissure of the skull in false acephalia, and by the different degrees of the want of union between the two portions of the palate; in the trunk, by the spina bifida posteriorly and anteriorly by fissures of the chest and abdomen, through which the different viscera protrude. These fissures arise by the part remaining stationary at some of the degrees through which it passes. We are not however authorized by any phenomenon to admit with Tiedemann,† that they are caused by a want of development in those vessels, which in the normal state unite on the median line. It is much more correct to consider the deviations

* Mappus, *De acephalis.*—Meckel, *Beyträge zur vergleichenden Anatomie*, 1808, vol. i. part ii.—Id., *Pathologische Anatomie*, 1812, vol. i. ch. iii. and iv.—Tiedemann, *Anatomie der kopflosen Missgeburten*, Landshut, 1811.—P. Hostecks, *Diss. de monstrositatum origine*, Berlin, 1819.—F. Feiler, *Ueber angeborne menschliche Missbildungen*, Leipsic, 1820.—Geoffroy St. Hilaire, *Philosophie anatomique: monstruosités humaines*, Paris, 1823.—Serres, *Essai d'une théorie anatomique des monstruosités animales*: in the *Bulletin de la soc. méd. d' Em.*, September, 1821.—Duges, *chis chez le fœtus*; in the *Revue médicale*, vol. x. p. 353.

† *Anatomie der kopflosed Misgeburten*, p. 105.

of formation of all the parts situated near the fissure as the common effects of one and the same cause. We pass over the fissures in some particular organs which coincide with these monstrosities.

The imperfect development of the limbs, which presents so many degrees, expresses that of the two sides of the body. Sometimes all the limbs are totally wanting; and again, one only is deficient, either in whole or in part: they often present only some defect in their development.

§ 469. *B.* The *abnormal redundance* in the number of the organs is the reverse of their imperfect development. This deviation of formation presents numerous varieties. They relate principally to the manner in which the supernumerary parts unite with the others; this permits the abnormal redundance to be divided into *common* and *generic.* In the former, the redundant organs are united to the others in the same manner as the latter are joined together. In the latter, they are united the same as the fœtus is with the organism of the mother.

The principal circumstances of the common redundance are:—

1st. The degree varies both in the number and development of the parts.

α. The redundant parts rarely, perhaps never, are more than double, so that it may also be called *doubling.*

β. This doubling extends to some small part of the body more frequently than to a greater extent; for the smaller organs are double more frequently than those which are larger. The fingers are redundant more frequently than an entire limb, a trunk, or a head.

γ. The supernumerary part is often below the standard, in regard to the size and number of the parts which compose it. The supernumerary fingers are often only fleshy appendages; their bones, simply the excrescences of a normal bone, &c. The redundancy, however, extends to an entire region more frequently than to a single system. If the number of vertebræ be increased by one, we find the same increase in the nerves, the vessels, and the muscular slips of the same region.

2nd. The external parts alone are double much more frequently than the internal, or the central parts present this anomaly, no similar one being presented externally. Hence, we find supernumerary fingers (*digiti*) more frequently than abnormal vertebræ; the former exist often, even without any increase in the number of the corresponding parts of the metatarsus, the metacarpus, the tarsus, and the carpus, while the contrary never occur. So likewise we not unfrequently find more than two mammæ, while a redundancy of the viscera is very extraordinary.

3d. Those parts, which in the normal state are numerous, are abnormal much more frequently than those which are single, or at most double. Hence we find supernumerary fingers, toes, or teeth, much more frequently than other parts.

4th. The most complex parts are doubled less frequently than those of simpler structure.

5th. A multiplication in one part is usually attended with a diminution in number, or in development in another part.

6th. The multiplication of the whole body takes place, 1st, in the dimension of thickness, forward or backward; 2d, in the dimension of length, upward or downward; 3d, in the dimension of breadth, on the right or left side

§ 470. *a. Alterations in regard to quality.* This sectioncomprises two classes of anomalies, those in regard to the *form*, or to the *situation*, or to both at the same time.

α. Anomalies in form are seen in the division of parts naturally *simple*, or in the union of parts generally separated. The vascular system, the osseous system, and the spleen, furnish us with examples of the first; the same two systems, and the kidneys, present instances of the second.

β. Anomalies in situation alone are rarely primitive, in the strictest sense, although often met with as resulting from retarded development. We however find sometimes a greater or less portion of the intestinal canal in the chest, the kidneys situated lower than usual, the heart too low, and sometimes, though very rarely, even in the abdomen.

γ. The inversion of parts ought to be considered as the union of anomalies in situation and form, since we not only find in the left side parts which should be in the right, and *vice versa*, but they are also formed of a directly opposite type. This lateral inversion also presents very different degrees. The inversion from before backward resembles that from one side to the other; it takes place in the greatest degree, when the upper half of the body is turned forward and the lower backward. Inversion from before backward is also seen in the surface of the body; the other is not apparent externally, as it effects only the asymmetrical organs.

b. The second species of anomaly relative to the quality or *hermaphrodism*, is seen in the general form, independently of the genital organs, either when the body externally is of a character contrary to that of the sex (*viragines et mares effeminati*), or when a part of the body is formed in the type of the male, and the other in that of the female.

DESCRIPTIVE ANATOMY.

PART II.

OF THE TOPOGRAPHY OF THE ORGANIC SYSTEMS.

BOOK I.

OF OSTEOLOGY.

§ 471. The topography of the *osseous system** should precede that of all the other organic systems, since the situation, the direction, and

* Besides the books already mentioned, those most in repute upon osteology are,

A. DESCRIPTIVE.

Hippocrates, *De articulis liber*, in *Opp. omn.*, Venice, 1526.—A. C. Celsus, *De re medicâ liber octavus, editio nova curante Fouquier et Ratier*, Paris, 1823, 8vo.—Galen, *De ossibus*, Lyons, 1535.—J. Sylvius, *In Galenum de ossibus commentarii*, Paris, 1561.—Fallopius, *Expositio in librum Galeni de Ossibus*, Venice, 1571.—Eustachius, *Ossium examen*, in *Opuscul. anat.*, 1726.—P Paaw, *Primitiæ anatomiæ de humani corporis ossibus*, Leyden, 1615.—Riolan, *Osteologia ex veterum et recentiorum præceptis descripta*, Paris, 1614, in 8vo.—Leclerc, *Ostéologie exacte et complète*, Paris, 1706, in 8vo.—B. S. Albinus, *De ossibus corporis humani*, Leyden, 1716.—Bochmer, *Institutiones osteologicæ*, Halle, 1751.—Tarin, *Ostéographie* or *Description des os de l'adulte, du fœtus*, &c., Paris, 1753.—B. S. Albinus, *De sceleto humano*, Leyden 1762.—J. T. Walter. *Abhandlung von trocknen Knochen des menschlichen Körpes*, Berlin, 1763.—Lecat, *Cours abrégé d' ostéologie*, Rouen 1763.—Knackstedt, *Osteologie oder Beschreibung der Knochen des menschlichen Körpers*, Brunswick, 1781.—C. T. Hoffmann, *Succincta descriptio ossium et musculorum*, Nuremberg, 1783.—Sandifort, *Descriptio ossium hominis*, Leyden, 1785.—Berholdi, *Initia doctrinæ de ossibus et ligamentis corporis humani*, Nuremberg, 1794. Sommenburg, *Compendium syndesmo osteologicum*, Berlin, 1797, one of the most remarkable productions of medical literature.

B. PLATES.

B. S. Albinus, *Tabulæ sceleti et musculorum*, Leyden, 1747; *Tabulæ ossium humanorum*, Leyden, 1753.—G. G. Muller, *XXII. Kupfertafeln, welche die Knochen das ganzen menschlichen Körpers vorstellen*, Francfort, 1749.—Trew, *Tabulæ osteologicæ*, Nuremberg, 1767.—Innes, *Eight anatomical tables of the human body*, Edinburgh, 1776. Loschge, *Die Knochen des menschlichen Körpers und ihre vorzugl. Bander*, Erlangen, 1789.—E. Mitchell, *A series of engravings respecting the bones of the human skeleton*, Edinburgh, 1820.

C. DIFFERENCES IN REGARD TO SEX.

Ackermann, *De discrimine sexuum præter genitalia*, Wurzbourg, 1788.—Sœmmerring, *Tabulae sceleti feminini*, Francfort, 1797.

D. DIFFERENCES IN REGARD TO RACES.

Sœmmering, *Ueber die körperlichen Verschiedenheit des Europaers vom Neger*, Francfort, 1785. Other descriptions and plates refer solely to the cranium,

the forms of the latter, are for the most part determined by those of this system.

§ 472. The number of the bones in the normal state amounts to two hundred and fifty-two; fifty-six of which belong to the trunk, sixty-two to the head, sixty-eight to the upper, and sixty-six to the lower extremities.

The bones of the trunk are,—

1st. The twenty-four *vertebræ*.

2d. The *sacrum*.

3d. The four bones of the *coccyx*.

4th. The twenty-four *ribs*.

5th. The three bones of the *sternum*.

The bones of the head are,—

1st. The seven bones of the skull, viz. the *spheno-occipital* bone, the two *temporal* bones, the two *parietal* bones, the *frontal* bone, and the *ethmoid* bone.

2d. The four bones of the ear; the *malleus*, the *incus*, the *stapes*, and the *os orbiculare*.

3d. The fourteen bones of the face; the two *upper maxillary* bones, the two *malar* bones, the two *palate* bones, the two *nasal* bones, the two *lower turbinated* bones, the two *lachrymal bones*, the *vomer*, and the *lower maxillary bone*.

4th. The thirty-two *teeth*.

5th. The five pieces of the *hyoid* bone, a central and four lateral pieces.

The bones of the upper extremities are,—

1st. The two bones of the shoulder, the *clavicle* and the *scapula*.

2d. One to the arm, the *humerus*.

3d. Two to the fore-arm, the *radius* and the *cubitus* or *ulna*.

4th. Eight to the carpus, the *scaphoid* bone, the *semi-lunar* bone, the *pyramidal* bone, and the *pisiform* bone, the *trapezium*, the *trapezoides*, the *os magnum*, and the *unciform* bone.

5th. Five to the metacarpus.

6th. To the fingers, fourteen *phalanges*, two of which are for the thumb, and three for each of the fingers. Finally,—

7th. Two *sesamoid* bones.

The bones of the lower extremities are,—

1st. One to the haunch, the *coxal* or *iliac* bone (*os innominatum*).

2d. One to the thigh, the *femur*.

3d. Three to the leg, the *tibia*, the *fibula*, and the *rotula* or *patella*.

4th. Seven to the tarsus, the *astragalus*, the *calcaneum*, the *scaphoides*, the *cuboides*, and the three *cuneiform* bones.

5th. Five to the metatarsus.

and will be pointed out hereafter. Some also treat of the differences in the bones during their development, and also of their diseases.

E. We have already mentioned the general works on the diseases of the bones. In describing each bone we shall mention those in which details of their anomalies may be found.

6th. To the toes, the fourteen *phalanges*, arranged as in the hand Finally—

7th. Two *sesamoid* bones.

Most of these bones exist in pairs, that is, one on each side. Thirty-eight are single, and situated on the median line, but are, however, formed of a right and a left similar half; we have, as examples, all the bones of the vertebral column, the pieces of the sternum, the middle pieces of the hyoid bone, the vomer, the spheno-occipital bone, the frontal bone, the ethmoid bone, and the lower maxillary bone. We shall leave the teeth, until we treat of the alimentary canal.

The order in which the bones are formed calls our attention, first, to the bones of the trunk, not only because this region is first developed, but because many of the other bones of the body, particularly those of the head, are formed in their type.

SECTION I.

OF THE BONES OF THE TRUNK.

§ 473. The bones of the trunk may be divided into two classes; the *essential* or the *primitive bones*, and the *accessory* or the *secondary bones*. The first comprise those forming the vertebral column (*columna vertebralis*); the second, those situated opposite this column, and those which unite these to the spine. The first comprehends the *vertebræ*, the *os sacrum*, the *ossa coccygis;* the second, the *sternum*, and the *ribs*.

CHAPTER I.

OF THE PRIMITIVE BONES OF THE TRUNK, OR OF THE VERTEBRAL COLUMN.

ARTICLE FIRST.

GENERAL REMARKS ON THE PRIMITIVE BONES.

§ 474. The *vertebral column* * occupies the centre of the posterior face of the trunk, and determines its length. When perfectly developed, it is composed of twenty-nine, rarely of thirty bones. The upper twenty-four bones are called the true *vertebræ* (*vertebræ veræ*), the twenty-fifth is the *sacrum*, and the four lower bones belong to the

* For some remarks on the vertebræ considered in the whole animal series, and for the different osseous parts or organic elements which form them in their state of perfect development, and before all fusion caused by the rudimentary state of some one of these elements, see the *Considérations générales sur la vertebre*, by Geoffroy St. Hilaire, in the *Mémories du Museum*, vol. ix. p. 89.

coccyx. The first twenty-four vertebræ are called *true* vertebræ, to distinguish them from those pieces of bone composing the sacrum, which are, at first, so many vertebræ, but become fused into a single bone when the body is entirely developed, and hence are called *false* vertebræ. All the bones which form the vertebral column are arranged one upon another, covering each other reciprocally, and intimately united, so that the dimension in length is much greater than any other in the column they form; each piece possesses but a slight degree of mobility, and this degree varies in the different regions. The vertebral column does not describe a perfectly straight line but a curve, for its superior or *cervical* portion (*pars cervicalis*) is convex forward, and concave backward, the *dorsal*, *thoracic*, or *pectoral* portion (*pars dorsalis*, s. *thoracica* s. *pectoralis*) is concave forward, the *lumbar* or the *abdominal* portion (*pars lumbaris*, s. *abdominalis*) is convex forward, and concave backward and, finally, the *sacral* part (*pars sacralis*) is very concave forward, and convex backward. This curve is most marked in the sacral and in the lumbar regions.

I. GENERAL CHARACTER OF THE BONES OF THE VERTEBRAL COLUMN.

§ 475. All bones of the vertebral column present certain general characters. If we include the pieces of the coccyx among them, we can make no general remark, except that they have a rounded form; but when the coccyx is not included, we can assign to them characters much more precise. The most general condition of all the vertebræ is their annular form. This ring, the opening of which is always very considerable in proportion to the mass which forms it, gives support to several processes. The annular form is connected with one of the uses of the vertebral column, which is to lodge the spinal marrow. The name of *medullary foramen* (*foramen pro medulla spinali*, *foramen medullare*) is applied to the hole in each of the vertebræ, and that of *medullary canal* (*canalis pro medulla spinali*) to the channel resulting from the union of all the foramina of the vertebræ placed one upon the other.

The part of the vertebral column situated before the spinal marrow, is, except in one place, the strongest and thickest; hence it is called the *body of the vertebra* (*corpus vertebræ*). It is always a little narrower on its exterior face and its two sides, so that its superior and its inferior faces project slightly beyond the lateral faces. The remainder of the lateral portion and all the posterior part of the vertebra is called the *arch* (*arcus*). The body is always straight and transverse, and the arch very convex. The processes on one hand contribute to a second use of the vertebral column, that of giving attachments to the muscles, which move it, the ribs and the skull, and also to strengthen the union of the vertebræ. They may then be divided into *articular* and *muscular* processes (*processus articulares et musculares*), according to their principal uses, though all seem to fulfil these two functions at the same time. The processes originate only from the arches of the vertebræ.

There are always seven processes. Four are *articular*, (*processus articulares, condyloidei*), these are also called the *oblique processes* (*P. obliqui*), and derive their name from the direction of their cartilaginous articular surfaces; we find on each side a superior and an inferior, which arise from the lateral part of the arch. Of the other three, which are *muscular*, two, one on the right, the other on the left, arise transversely from the arch, between the superior and the inferior articular processes; these are called the *transverse processes* (*P. transversi*) from their direction.

The third is situated on the median line; it arises from the middle of the posterior portion of the arch and proceeds backward. It has been called the *spinous process* (*P. spinosus*), as it is very long and pointed in many of the vertebræ.

In all the muscular processes we distinguish a *base* (*basis*), and a summit (*apex*).

Between the base or the anterior extremity of the arch of the vertebræ and the two articular processes of each side, the upper and the lower edge of the arch present *grooves* (*incisura vertebralis*); when the vertebræ are fitted to each other, these grooves form the *holes of conjunction*, or the *intervertebral foramina* (*foramina intervertebralia*), which communicate with the interior of the spinal canal, and through which the spinal nerves emerge.

§ 476. All the vertebræ are united, in the main, in the same manner and at the same points. The upper and the lower faces of the bodies are firmly attached to each other in their whole extent, by the fibro cartilages which admit of butslight motion. The arches and spinous processes are united by fibrous ligaments, and the articular or oblique processes are connected together by capsules.

II. OF THEIR DEVELOPMENT.

§ 477. Besides these general characters presented by the vertebræ when perfectly formed, they resemble each other in the essential characters in their mode of development. In fact, they are always formed of at least three pieces; a middle piece corresponding to the body, and two posterior and lateral pieces representing the two halves of the arch. Each probably arises by six or eight pieces, since we find a small nucleus of bone at the extremities of the spinous and of the transverse processes, and also on the upper and on the lower face of the body. We have observed this in the bodies of several individuals eighteen years old; and the facts mentioned by Ungebauer* accord with our own experience. Perhaps by examining the vertebræ in young subjects, we shall ascertain that the body is formed by the union of the two lateral portions,† at leas twe have found this to

* *Epistola osteologica de ossium trunci corporis humani sero osseis visis earumdemque genesi*, Leipsic, 1739.

† Beclard thinks differently; he adduces an argument drawn from the anterior *spina bifida*, which very rarely, although sometimes, occurs, and in the neck only, because the fore part of the vertebral column developing itself from the centre

be the case in the upper pieces of the coccyx, and several times even in the body of the first cervical vertebra, and also in the odontoid process of the second. The analogy of the sternum and of the spheno-occipital bone also leads us to believe that this is the case in all. Then the number of points of ossification is not three, as is generally asserted, but nine, or more properly speaking, eight. The lateral portions begin to appear at the third month; the body shows itself later. The terminal points of ossification of which we spoke are not visible till long after birth; for in the full-grown fœtus the processes of the vertebræ are not ossified. When the child is born, the different osseous points are still perfectly distinct.

III OF THE SEXUAL DIFFERENCES.

§ 478. The bodies of the vertebræ are flatter, the transverse processes stronger and straighter in the male. In the female, these last are inclined a little backward so that the groove between them and the arch is deeper; the spinal canal and the inter-vertebral foramen are also broader.

ARTICLE SECOND.

OF THE DIFFERENCE BETWEEN THE TRUE AND THE FALSE VERTEBRÆ.

§ 479. The characters hitherto mentioned apply both to the true and to the false vertebræ.

The true vertebræ differ from the false vertebræ of the sacrum, as they are not fused together when fully developed. We must however remark, that, after the age of fifty, we often find the true vertebræ united in one or many parts of the vertebral column.

The true are also distinguished from the false vertebræ, in their mode of ossification. In the normal state, the lateral portions unite on the median line, to form one piece before blending with the body; in the sacrum, however, they are separated from one another long after they are united to the body.

towards the two extremities, while the posterior lateral parts are developed successively from above downward, this separation ought to occur backward and downward, which is most common, or forward and upward. He rejects also analogous proofs drawn from the anatomy of tetards, of birds, and of rabbits, as resting on erroneous observations. Having studied the commencement of ossification in the bodies of the vertebræ of the tetard and frog, he observed that it was a single point; the same occurs also in the other batracia, in the mammalia, and in birds. As to the cause of error, he thinks it arises from making observations upon subjects too young, and from considering the peduncle of each apophysis as the commencement of the body. On this subject we must remark, that in those animals which have a horizontal position, the body of the vertebra being the least important part, is developed the last, by a relatively smaller point, while in man the reverse is true, especially in regard to the lumbar, the sacral, and the inferior dorsal vertebræ. See *Nouveau Journal de médecine*, vol. viii. 1820, p. 82. F. T.

ARTICLE THIRD.

PARTICULARS OF THE TRUE VERTEBRÆ.

§ 480. The true vertebræ are divided into the *cervical* (*vertebræ cervicales*), the *thoracic*, or the *dorsal* (*V. thoracicæ dorsales*), and the *lumbar* (*V. lumbares*) vertebræ, according to the region of the trunk which they occupy. We number seven cervical, twelve dorsal, and five lumbar vertebræ. They differ very much in their size and thickness, in their form, and the size of the spinal canal, and finally in the form and proportion of their parts.

§ 481. 1st. The vertebræ gradually increase very much in size, from above downward, so that the cervical are the smallest, and the lumbar vertebræ the largest. The bodies particularly become broader, higher, and thicker. A lumbar vertebræ is four times as massive as a cervical vertebræ.

§ 482. 2nd. The spinal canal is smaller and rounder in the dorsal vertebræ, particularly in the central; it is largest in the upper lumbar vertebræ. In fact, that of the first cervical vertebræ is much larger than any of the others, but this canal is not entirely filled with the spinal marrow. This opening is more oblique in the upper lumbar vertebræ; in the lower lumbar, and in the cervical vertebræ, it has a triangular form, the summit of which is directed backward.

§ 483. 3d. *a*. The bodies of the different vertebræ differ from each other in several respects. In the cervical vertebræ, this part is not only smallest but it is very low in proportion to their depth and breadth. The upper face is a little concave from before backward, and especially from right to left, for the two lateral edges are very much raised above its level; it also inclines forward. The lower face is equally and even still more inclined in the same direction, but a little flattened towards its lateral edges.

The upper face of the upper dorsal vertebræ offers but slight traces of this arrangement of the body. In them, the upper and lower faces are perfectly straight, except in the centre, where they are a little depressed.

The bodies of the dorsal vertebræ become much thicker from before backward, and from above downward, less from one side to the other, so that the body of the middle is narrower than that of the upper dorsal vertebræ, and of the lower cervical vertebræ, but the inferior are the largest in every sense.

The contraction of the body mentioned before is marked most strongly in the dorsal, and least in the cervical vertebræ.

The bodies of the dorsal vertebræ are particularly distinguished from those of all others by having small articular surfaces situated on the sides, immediately before the union of these same bodies with the two portions of the posterior arches. We generally find an upper and a lower on each side of the body, the former being continuous with the

upper edge, and the latter with the lower edge of the lateral face. Each of these facets is imperfect; they do not become complete until they unite to the corresponding facet of the vertebra below, so as to form with it only one cavity, composed of the two portions joined together at an obtuse angle, the upper being the smaller and the inferior the larger. In the last three vertebræ, we find on each side only one of these articulating surfaces. The tenth has only the usual upper semi-facet which unites with the inferior facet of the ninth. On the eleventh and twelfth, we see one only, which is straight and separated from the upper edge. Hence why those of the superior ten dorsal vertebræ are called *common lateral articular facets*, and those of the last two, the *proper lateral articular facets* (*facies articulares laterales communes et propriæ*). They receive the heads of the ribs.

§ 484 *b*. The processes of the vertebræ differ considerably.

First, of the articular processes. The *articular processes* are less oblique in the cervical vertebræ; their direction in the first two is almost horizontal. In the dorsal vertebræ, especially the lower, they are almost perpendicular; the same is true also of the lumbar vertebræ. Their articular surfaces are arranged in the cervical vertebræ, so that the superior look upward and backward, the inferior downward and forward. In the dorsal vertebræ the superior are turned directly backward, the inferior directly forward. In the lumbar vertebræ the superior are directed inward, and the inferior outward. The last vertebra in this region is the only one which in some measure resembles the formation of the dorsal vertebræ in this respect.

The articular facets of the lumbar vertebræ are the strongest and highest, and those of the cervical vertebræ are the most feeble. The broadest are found in the first vertebra of the neck.

These surfaces also vary in form. They are straight in all the cervical and dorsal vertebræ, while in the lumbar vertebræ the superior are concave and the inferior convex. Those of the first cervical vertebræ are very deep.

In the cervical vertebræ, excepting the first, and in the upper dorsal vertebræ, their greatest breadth is from one side to the other, and in the inferior dorsal and in the lumbar vertebra it is greatest from above downward. In the first cervical vertebra, the superior are broader from before backward than from one side to the other, while the inferior are round, as are also the superior of the second cervical vertebra, which correspond to them.

The form and proportions of the articular processes and of their surfaces admit then of only one movement in the lumbar region, viz. from above, downward; while they have also a lateral motion in the regions of the back and the neck. At the lower part of the dorsal region, the motion from above downward is very limited by the height of the processes and by their greater perpendicular direction, and the lateral motion by the backward direction of the transverse processes which closely connect the joint. The vertebræ of the neck have the most motion,

because, their surfaces being more horizontal, their articular processes are shorter.

§ 485. The transverse processes present no less remarkable differences.

The longest and strongest are those of the upper and middle dorsal and the superior lumbar vertebræ. Those of the cervical vertebræ are shorter, except those of the first, which are long. The smallest are those of the last two dorsal vertebræ.

Their direction varies. In the cervical vertebræ they are directed forward; in the dorsal vertebræ, especially the inferior, backward; and in the lumbar vertebræ they are more transverse, and incline also a little backward.

They differ still more in their form. In this respect the cervical vertebræ are distinguished from the others, as their transverse processes are perforated from above downward, and a round canal is formed, which is sometimes divided by a transverse ridge of bone into an anterior and a posterior part, the latter being generally the smaller. This canal gives passage to the vertebral artery, and hence has been called the *vertebral canal* (*foramen vertebrale*). Hence why the transverse processes are considerably broader from before backward, and why their anterior and posterior edges, especially in the lower five cervical vertebræ, are more or less curved upward; they form a groove, in which the nerve from the spinal canal crosses the direction of the vertebral artery which passes before it.

This groove is strongly marked in the sixth cervical vertebra. That part only of the transverse process which is situated behind the vertebral canal corresponds to the transverse processes of the other vertebræ. The anterior corresponds to the ribs; however, the former is usually called the *posterior* root, and the latter the *anterior* root, of the transverse process.

The outer part of the vertebral foramen is sometimes imperfect. The first cervical vertebra is the only one in which the portion of the transverse process situated outside of this opening, and which is considerably broad from before backward, is at the same time very broad from without inward.

The transverse processes of the dorsal vertebræ are the most massive. They are not terminated externally by a point, as are those of the other vertebræ, but gradually swell out, and their thickness equals, or nearly equals, their breadth. The upper ten are distinguished from the others, as we perceive on the anterior face of their summits an articular surface (*facies articularis transversalis*) covered with cartilage, which unites to the tubercles of the ribs. This surface is concave in the upper vertebræ, but plain and often convex in the lower; in the upper it is turned forward and upward; in the others its direction becomes more and more oblique outward and downward. Its extent also diminishes as it approaches the loins.

The transverse processes of the lumbar vertebræ increase in length from the first to the third, and afterwards shorten from the latter to

the fifth, so that in this last they form only small thin points. They are very much compressed from before backward, and consequently are much weaker than those of the dorsal vertebræ. Their base usually projects at its posterior part into a small tubercle called the *accessory process* (*processus accessorius*), which is found in these vertebræ only.

§ 486. The spinous processes of the cervical vertebræ are thinner upward and downward, and broader across than those of all the other vertebræ; their superior face is convex, and the inferior concave; their posterior extremity terminates in two teeth, one on the right, the other on the left, which diverge, and are often bifurcated. They increase much in length from the first cervical vertebra, and are almost horizontal, although a little inclined downward. We shall mention their differences in the first, second, and seventh cervical vertebræ when describing these vertebræ.

The spinous processes of the dorsal vertebræ are the longest of all: they lengthen especially from the first vertebra to the seventh; at the same time they are thicker and triangular. The upper ones are the broadest in proportion to their height; but they gradually become thinner, so that at last their upper edge is sharp. Slightly contracted in the middle, they always swell out at their point, and terminate in a single small tubercle.

The spinous processes of the lumbar vertebræ are a little longer than those of the last three dorsal, and longer also than those of the cervical vertebræ. They are the highest and most compressed of all, so that in this respect they offer an arrangement contrary to that seen in the spinous processes of those of the neck. Their direction differs from that of the others: it is not directly backward, or backward and downward, but is from behind forward, and from below upward.

ARTICLE FOURTH.

OF THE SPECIAL CHARACTERS OF SOME OF THE TRUE VERTEBRÆ, VIZ. OF THE FIRST, THE SECOND, AND THE SEVENTH CERVICAL VERTEBRÆ.

§ 487. The first, second, and seventh cervical vertebræ present some peculiarities in their forms, and deserve a separate description.

A. NORMAL STATE.

I. Of the first cervical vertebra.

Although all the cervical vertebræ are characterized by a less difference between the body and the arch, this is much more marked in the first cervical vertebra than in the others. This vertebra is called the *atlas*. Its middle and anterior portion is broader across than in any other direction, as in all vertebræ, but it is thinner from before back-

ward than the arch itself, which almost equals it in height also. Hence this part is not called the body, but the *anterior arch* (*arcus anterior*). This vertebra is distinguished from all others by the thinness of the superior and inferior edges of its anterior arch, while in the other vertebræ, except the second, the thickness from before backward exceeds the height. These two edges are destitute of cartilage. On the middle of the anterior face is a *small tubercle* (*tuberculum anterius*), to which a slightly concave and cartilaginous *articular facet* (*sinus atlantis*, s. *medius*) on the posterior face corresponds.

The posterior arch is more oblique than in all the other vertebræ. From its centre arises a *tubercle* (*tuberculum posterius*) which frequently is almost imperceptible, but sometimes is also bifurcated, and goes horizontally backward.

The anterior parts of the posterior arch, which support the transverse and articular processes, are much stronger in proportion to the other parts of the atlas than in the other vertebræ; hence they are termed the *lateral masses* (*massæ laterales*). We have already mentioned the form and arrangement of the articular processes. Behind each process, and not, as in the other vertebræ, before each one or between it and the body, is a slight depression, forming the *upper intervertebral groove* (*incisura intervertebralis superior*, s. *sinus lateralis*, s. *posterior*), which gives passage not only to the first spinal nerve, but also to the vertebral artery and vein. This groove is sometimes changed into a canal by a ridge of bone, which extends from the posterior extremity of the upper articular process to its posterior edge. Sometimes also another ridge of bone detaches itself from the posterior root of the transverse process, and extends to the posterior edge of the posterior arch, also forming a small canal. The upper articular surface is here directly continuous with the body, while in the other vertebræ it is separated from it by a groove. In the centre of the internal face of the lateral masses, we observe a considerable depression and asperities which are seen only in the atlas.

The first cervical vertebra is the broadest of all, if we except the third lumbar vertebra. This circumstance is not to be ascribed, as in the other vertebræ, to the breadth of its body or to the length of its transverse processes, but to the great development of its articular surfaces, which depends upon its articulation with the occipital bone.

The first cervical vertebra differs from the others in its mode of articulation by the greater looseness in the parts which hold it. In fact, the upper and lower edges of the posterior arch are not connected with the occipital foramen and with the body of the second vertebra by a fibro cartilage, but by much weaker fibres.

II. Of the second cervical vertebra.

§ 488. The second cervical vertebra is distinguished from the others particularly by the height of its body, which is elevated considerably above its articular parts. This projection is called the *odontoid process*

(*processus odontoides*, s. *dens*). It is narrower than the body, and rounded. Above the *base* (*basis*) it becomes narrow; this part is called the *neck* (*collum*). Towards its extremity it bulges again into a *small head* (*capitulum*), and finally terminates in a blunt *summit* (*apex*).

The anterior face of the head presents a slightly convex, smooth, cartilaginous surface, which corresponds to the excavation on the anterior arch of the atlas. A similar one is seen on the posterior face. The odontoid process of the second cervical vertebra seems to divide the body of the first cervical vertebra, to a certain extent, into an anterior and a posterior part, of which the former alone is ossified, while the other is the *transverse ligament of the first cervical vertebra*. In this vertebra also the upper articular surfaces is uninterruptedly continuous with the body, and sometimes even there is no superior groove behind it, while the inferior groove is found as usual. The upper articular process is not situated above, but directly before the lower; so that it is supported on the body which is enlarged laterally, and its weight, consequently that also of the atlas and the cranium, bears upon the body, and not on the feeble and more moveable lateral portions.

The anterior face of the body presents two lateral depressions, and above, a longitudinal ridge, which corresponds to the anterior tubercle of the atlas.

The second cervical vertebra is stronger, and its spinous process is longer than those of the other cervical vertebræ, except the last.

The atlas, which articulates with it by means of the odontoid process and the upper articular processes, and the head, which in fact is one with the atlas, rotate upon this vertebra, and turn round its odontoid process as around an axis. Hence it has been called the *axis* (*epistropheus*, *axis*).

The second cervical vertebra differs from all the others in regard to its connections, articulating not only with that which precedes and follows it, but also with the occipital bone, by its upper part; and farther, the upper part of its odontoid process is not connected with the lower edge of the vertebra situated above it.

III. Of the seventh cervical vertebra.

§ 489. The seventh cervical vertebra presents fewer peculiarities than the first two, and is particularly remarkable as uniting the characters of the cervical and thoracic vertebræ; so that it would be more correct to call it one of the latter; we should then have thirteen dorsal and six cervical vertebræ. * It resembles the cervical vertebræ only in the breadth and lowness of its body, and in the existence of the vertebral foramen. But the body of the first dorsal vertebra presents the same form, and the vertebral foramen here loses all its importance,

* This remark is so just, that were it not in obedience to long usage, we should not admit seven cervical and twelve dorsal vertebræ.

since the vertebral artery never passes through it ;* it is frequently deficient, and it sometimes exists in the dorsal vertebræ.

This vertebra resembles the dorsal in the great length of its transverse processes, which on each side suddenly increase at least four lines, while from the second to the sixth cervical vertebra they are of the same or of nearly the same length. It also resembles them in being thrown back, so that the medullary canal is farther backward than in the other vertebræ ; because it has on the lower part of the side of its body a small, lateral, articular semi-facet (*facies articularis lateralis*), which forms a complete surface by uniting to the upper semi-facet of the first dorsal vertebra ; and finally because its spinous process suddenly exceeds those of the other cervical vertebræ very much, and, although broader than those of the dorsal vertebræ, is not bifurcated, and is thicker than those of the cervical vertebræ. It has been called the *prominent vertebra* (*vertebra prominens*), because the posterior part of its body projects beyond the other cervical vertebræ.

B. DEVELOPMENT.

§ 490. These three vertebræ differ also from the others in their mode of development.

The atlas is usually formed like the other vertebræ as respects the number of its points of ossification, but differs in regard to the time at which they appear. In the second and seventh cervical vertebræ the number of points of ossification is not the same.

In the other vertebræ the body exists long before the fœtus is matured. In the atlas, on the contrary, we have rarely found it before the child is six months old. Of thirty skeletons of full-grown fœtuses, and even of children, in one only have we seen a round nucleus of bone, two lines in diameter, in the cartilage of the anterior arch. Even at the age of two or three years, the two lateral masses are frequently united only by a band of cartilage containing one or more irregularly formed osseus nuclei, which are placed one at the side of the other. Some symmetry usually exists between the right and the left half of the body in this respect, so that although ossification often proceeds farther on one side than on the other, it never extends beyond the median line ; but in some few instances, even when the cartilage has entirely disappeared, we find the body formed of two very unequal parts, doubtlessly because of two or more osseous nuclei which are usually found on one side ; the internal is united with that of the opposite side sooner than with the nucleus next to it on the same side. At the same time we sometimes perceive a round nucleus of considerable size between the posterior extremities of both sides. This nucleus unites with the halves of the arch much earlier than the anterior, from which it is entirely separated, although by a very thin layer of cartilage, long after the different parts of the other vertebræ are fused in a single piece.

* Sœmmerring (*Knochenlehre*, p. 259) has mentioned this, and we have frequently verified his remark.

We have never seen, what Bichat asserts is the most common arrangement, that the atlas is developed by five points of ossification, one for the anterior arch, two for the posterior arch, and one for each of the lateral masses.

The second cervical vertebra is developed, leaving out of view its small processes, by at least five points of ossification, and not by four, as is generally said; for the odontoid process is at first formed of two symmetrical osseous nuclei, which are usually visible at the end of the seventh, and even in the middle of the eighth month of uterine existence; they are at first united and much smaller than the nucleus of the body, but exceed it in size in the full-grown fœtus, at which period they have long been united. Besides these, two other nuclei probably exist, which do not belong to all the other vertebræ; we refer to a large, round, osseous germ, situated forward, between the nucleus of the body, and that of the odontoid process, and the anterior extremity of the lateral mass, and which is much narrower from before backward than the body. We have almost always found it in children less than a year old, and even till the third year, although lessened in size, and to be seen only on one side.*

The osseous germs seen first are those of the lateral masses; next we observe that of the body, and then those of the odontoid process; those which appear last are the intermediate germs, which are not developed till after birth.

The halves of the arch in the axis and the atlas unite later than in the other vertebræ, and among all the atlas is that in which they most frequently do not unite on the median line. In the second vertebra the two osseous germs of the odontoid process are first united, then the posterior extremities of the lateral masses fuse. The intermediate germs, which are the last developed, then unite with the body and with the lateral masses; the body is fused with the latter; finally, the odontoid process unites also with them, so that the last trace of separation of the different osseous nuclei is a transverse furrow on the anterior face, between the body and the odontoid process.

The seventh cervical vertebra is developed by five points of ossification. Besides the three which usually exist, the anterior circumference of the vertebral canal is already formed in great part in the fœtus of seven months, by a separate oblong osseus nucleus, which extends from the lateral parts of the body to the posterior root of the transverse process. The anterior root is then developed separately, while in other cervical vertebræ it is merely a prolongation, the anterior and internal extremity of the transverse apophysis turned outwardly. Our observations have satisfied us that this arrangement, which Hunauld † considers simply as a variety, ought to be regarded as the normal state, as Sue ‡ and Nesbitt § think, althoughit is not mentioned in the trea-

* Nesbitt (*Osteogenie*. p. 66) mentions these osseous particles as existing also in the fœtus at birth; but we have never seen them.

† *Mem. de l'ac. des sc.*, 1740. p. 537.

‡ *Mem. prés. a l'ac. de Paris*, vol. ii. p. 572.

§ *Osteogenie*, p. 66.

tises on osteology. The union does not take place till after the second year. This peculiarity also demonstrates that it would be more proper to regard the last cervical vertebra as the first dorsal; for the small bone in question is evidently the rudiment of a rib, corresponding only to the neck of this rib, but representing it perfectly, and differs from the other ribs because it does not unite to the sternum by means of a cartilage, but fuses regularly with the vertebra to which it is united; * but it often remains distinct during life, and elongates itself like a rib. † The seventh cervical vertebra approximates those of the neck and back still nearer than they have hitherto appeared, as the anterior root of their transverse process decidedly corresponds to a rib, although it has not been developed by a special point of ossification.

The transition from the cervical to the dorsal vertebræ would seem still more gradual if, as we think ourselves authorized to conclude from facts, the sixth cervical vertebra is also formed by the union of five osseous germs. In a child which died when nine months old, we found a small rounded nucleus of bone on each side, next to the body, in the part corresponding to the anterior and internal extremity of the anterior root. We have even seen traces of this bone in another child, two years old. This nucleus, however, is much smaller than in the seventh vertebra, and there is only a simple layer of cartilage extending from it to the outward extremity of the posterior root, before the vertebral foramen. Besides, judging from the last instance, it never unites just at the posterior root, but the internal extremity of the lateral part glides forward and outward between them.

The second, sixth, and seventh cervical vertebræ resemble each other then very much in their mode of development, so that we are authorized to consider this intermediate rounded nucleus of bone as the rudiment of a rib, although in truth it is very imperfect. We ought also to consider the small lateral germs in the body of the axis as allied to it. It is then somewhat remarkable that they are found exactly in the upper and lower cervical vertebræ; in the latter, because the ribs arise from them; in the former, because the articular portions of the occipital bone and the styloid processes of the temporal bone result from their development and enlargement. (*a*)

* This peculiarity of the seventh cervical vertebra is important in two respects; first, it establishes between the skeletons of the mammalia and of the other vertebrated animals a greater analogy than has hitherto been admitted; for an analogy to the upper ribs of birds and reptiles had never been found in the mammalia. Secondly, it furnishes a new argument in support of the law that the formations which are transitory in the superior animals become permanent in those of the inferior classes.

† Meckel, *Handbuch der pathologischen Anatomie*, vol. ii.—*Deutsches Archiv. für die Physiologie*, vol. i. part iv. fig. 6.

(*a*) Most anatomists distinguish also,—

1st. The *first dorsal* vertebra. It presents an articular face above, and a semi-facet below, on the sides of its body.

2d. The tenth dorsal vertebra. It frequently presents an articular face on both sides of its body.

3rd. The eleventh dorsal vertebra. Its body is almost round, and presents an entire articular surface on each side; its transverse processes are very short, and have no articulating surface.

ARTICLE FIFTH.

OF THE FALSE VERTEBRÆ.

I. OF THE SACRUM.

§ 491. The *sacrum*, or *sacral bone* (*os sacrum*, *clunium*, *latum*), follows the last lumbar vertebra, with which it is articulated in the same manner as two vertebræ are united. Although not the last bone of the vertebral column, it however supports it, being the broadest and the strongest.

Its form is irregularly quadrilateral, being larger and thicker upward, but becomes narrower and thinner downward. It resembles a large vertebra formed by the fusion of five placed over each other, and combines all the character of the true vertebræ. The *sacral canal* (*canalis sacralis*) extends from the upper to the lower extremity, between a central and anterior portion, the *body*, and a thinner posterior portion, the *arch*; this canal gradually contracts, especially from before backward. The upper face of the body is slightly concave, and covered with fibro-cartilage; the inferior, to which the first piece of the coccyx is attached, is also covered with cartilage. On each side of the arch is detached a transverse process; in the centre of the arch is a more or less interrupted series of elevations, which represent the spinous processes of the vertebræ. Along this crest we observe on each side, on the posterior face of the arch, another series of small asperities, which correspond to the articular processes. Finally, between these and the body we find holes called *sacral foramina* (*foramina sacralia*), which correspond to the intervertebral foramina.

The differences between the sacrum and a common vertebra arise principally because it is composed of several vertebræ fused together, and because this fusion occurs at points too where there is no union between the true vertebræ.

Hence we find no simple spinous processes, but spines sometimes separated and equal in number to the pieces of the sacrum, and sometimes all or many of them fused together in a *crest* (*crista.*)

The articular processes are fused, and instead of them are tubercles sometimes hardly perceptible. The two upper and the two lower are very distinct, and are called the *horns of the sacrum* (*cornua sacralia*). We usually find, instead of the broad, loose, and cartilaginous articular surfaces, only sharp and slightly projecting edges; sometimes, however, the inferior articular processes of the first false vertebra have also, like the other vertebræ, extensive and loose articular surfaces.

4th. The twelfth resembles the eleventh; but its lower articular process is convex and looks outward.

5th. The fifth lumbar vertebra. Its body is flat, and the lower surface is oblique to articulate with the sacrum.

The foramina from which the last spinal nerves emerge appear double, so that we have an *anterior* and a *posterior series of sacral foramina*. But these foramina open into the spinal canal at the same place, and are double only because the transverse processes are united at their superior and inferior edges, outside of the holes through which the nerves pass.

These foramina are the anterior and the posterior openings of one connected canal, of which the upper are much larger than the lower, and diminish much from above downward.

The halves of the arches of the sacrum are united late; so that the ring of the two lower false vertebræ not unfrequently remains imperfect during life.

The anterior face of the sacrum is more or less concave, and the posterior more or less convex, according to the sex. The former is smoother than the latter; it presents only four transverse ridges, placed each between two pairs of sacral foramina, and which are the traces of the primitive separation of the five vertebræ. We perceive also four pairs of anterior sacral foramina. The posterior face presents five ranges of eminences; one in the middle, which is unmated, formed by the spinous processes, and termed the *crest of the sacrum* (*crista sacralis*); near it, on each side, a second, which arises from the fusion of the articular processes; finally, outward, a third, which marks the fusion of the transverse processes with each other. Between these two pairs of eminences we find the four posterior sacral foramina.

The lateral face of this bone is very broad and thick at its upper part. Its anterior part is smooth, covered with cartilage, and called the *auricular surface* (*facies auricularis*); the posterior part is very rough. The lower portion of this surface is so thin that it seems simply an edge.

§ 492. The sacrum is developed in the following manner. Long after the bodies of the true vertebræ are perceptible, we see, in the fourth month of pregnancy, the bodies, then the lateral masses of the false sacral vertebræ. The lateral masses are not all formed of the same number of osseous germs, for there are two on each side in the three upper pieces, while we find only one in the two inferior. Of these two nuclei, one, which forms one half of the arch, is found backward; the other, forward: both unite with the body. The posterior faces of the lateral parts of each vertebra are developed long before the anterior parts, which form almost all the articular surfaces for the iliac bones. In this manner the twenty-one osseous germs, which compose the sacrum in the matured fœtus, are gradually formed. The first three false vertebræ contain five each; the other two have three. All have a central and larger piece, the nucleus of the body. The two inferior have on each side only the half of an arch, composed in the first three of two osseous germs—an anterior, which is curved forward, and a posterior, which is curved backward. They continue separate till the age of three years. However, the extremities of the two portions of

the arches which are turned backward and toward one another are developed, as are those of the inferior vertebræ, which in the full-grown fœtus are directed precisely from before backward. At the age of three years, the three pieces of the lower vertebræ begin to unite, and then the same occurs with the posterior and the anterior pieces of the lateral portions of the three upper pieces; finally, these lateral parts also unite with the body. We not unfrequently find in subjects five years old the first vertebra composed of five pieces, and even at seven years of age we can trace this former separation.

The bodies and transverse processes of the different vertebræ are joined together much later, and only when the growth is terminated; the same remark applies to the posterior extremities of the halves of the arches.

§ 493. The sacrum, before its growth is perfected, is very analagous to the other vertebræ, inasmuch as its false vertebræ are not yet united. The latter resemble the proper vertebræ in regard to their mode of development, being composed of a body and of lateral parts. However, the number of these lateral parts in the upper vertebræ differs from what occurs in most of the vertebræ; but among the cervical vertebræ we find some which arise also from the union of several pieces. A more important difference is that of the period at which these osseous pieces are developed and united. In fact, in the true vertebræ, the lateral masses, appear first; while in the false vertebræ the bodies are seen first. In the former, the posterior extremities of the lateral parts unite before the anterior are joined to the bodies; in the latter, they are fused with the bodies long before they are united to one another.

§ 494. The sacrum is articulated, at its upper part, with the body of the last lumbar vertebra by means of a fibro-cartilage, and with its inferior articular processes by two capsular ligaments; laterally with the os ilium by a fibro-cartilaginous mass and several fibrous ligaments, and with the os ischium by fibrous ligaments. Finally, its lower extremity is articulated by ligaments and cartilage with the first piece of the coccyx.

§ 495. The sacrum is wedged in between the iliac bones, and forms the posterior wall of the pelvis. It properly sustains and supports the vertebral column and the head. It however projects backward very much, and forms, at its point of union with the last lumbar vertebra, a very prominent angle, called the *promontory* (*promontorium*).

§ 496. The sacrum is one of those bones in which the differences of sex are very manifest, as it forms a constituent part of the pelvis; these depend upon the difference in the functions of the male and female. In the female it is much broader and shorter and much less curved than in the male. The promontory also projects more than in the male.(*a*)

(*a*) Cloquet states that the dimensions of the sacrum in the female are generally from 4 to 4 and a-half inches long; its breadth at the upper part nearly equals its length; at the lower part it is not more than 6 or 7 lines: from the middle and projecting part of its base to the first tubercle of its posterior surface, its thickness is 2 and 2 and a-half inches.

II. OF THE COCCYX.

§ 497. The *coccyx* (*ossa coccygis*) is a collection of the smallest and most imperfect vertebræ. As the inferior false vertebræ of the sacrum do not form a complete ring, because the two portions of their arch do not unite, so those of the coccyx present no trace of the posterior arch: and when we perceive at its posterior part two projections opposite to one another, which correspond to the lateral portions of the vertebræ, they are never long enough to touch.

§ 498. We usually find four bones of the coccyx, rarely five, and then always in the female. These pieces are placed one above another, like the true vertebræ, and form a series of bones convex backward and concave forward.

The upper piece, and generally the first only, is much more perfectly developed than the others. We can always distinguish in the first, and sometimes also in the second, a middle piece which is stronger, the *body*, and two lateral parts. The latter become two transverse processes, terminated by a blunt summit, turned a little forward, curved very much from below upward, which are the rudiments of the transverse processes, and two posterior, which are those of the articular processes. These latter are slightly inclined towards each other, but are not very distant from the posterior face of the body. They are always much elevated above the upper edge of the bone. Sometimes they are extended also beyond its base, but they never exceed its total height by the base, so as to produce a rudiment distinct from an inferior articular process. Sometimes we can see the superior *horns* and the transverse processes only in the second coccygeal bone; the inferior horns are never seen, and the superior horns of the second are not arched towards each other.

The last two pieces of the coccyx are only round bones, the breadth of which is greater than the other two dimensions.

All these pieces rapidly diminish in size and development. In this respect they resemble the vertebræ of the sacrum, of which they are a continuation, and with which the coccyx is often fused in the same manner as the false vertebræ of this bone are united, that is, by the body, the horns, (articular processes), and the transverse processes, of which the last two are in general not directly united, but are attached only by fibrous ligaments. Sometimes only some pieces of the coccyx are fused together, and the others remain separate and distinct.

§ 499. In the full-grown fœtus, the first coccygeal bone generally contains at its centre a very small but distinct rounded nucleus of bone.* The others do not ossify till the seventh year. In a subject, two years old, instead of all the osseous germs, we found the second piece formed of two separate lateral halves.

* Albinus says that the whole coccyx remains cartilaginous till long after birth. This assertion however is not correct.

ARTICLE SIXTH.

OF THE VERTEBRAL COLUMN IN THE ABNORMAL STATE.

§ 500. The anomalies of the bones of the vertebral column may affect, 1st, the separate bones; 2nd, all of them collectively.

These two kinds of anomalies may be primitive or consecutive.

I. OF THE PRIMITIVE ANOMALIES.

§ 501. Here we must remark, generally, that of the different regions of the vertebral column, the fewest anomalies occur in the cervical vertebræ, at least as regards number; this depends upon the circumstance that the cervical vertebræ are more constant in number in the mammalia, proving that the influence of the general law extends even to the anomalies.

§ 502. A. *Anomalies in regard to quantity.* *a. Feebleness of formation.* It is marked in various ways.

a. By the defect of entire vertebræ. Of this anomaly there are several degrees. When the upper half of the body is not completely developed (§ 468), the pectoral or the whole cervical region is sometimes deficient; and when the skull is not perfectly developed, as in *acephalia falsa* (§ 468), one or more of the cervical vertebræ are frequently deficient. We have instances, however, of the absence of a vertebra when the formation is otherwise regular; but this rarely occurs in the neck; the regions in which it is most frequent are the lateral regions and that of the coccyx. Sometimes also only one half or the opposite halves of two vertebræ are deficient. We ought here to distinguish the *real* from the *false* or *apparent* defect; in the latter case, it happens only that a vertebra of one region assumes the characters of those of another region. This occurs, for instance, when there is an excess or defect of a pair of ribs, when the last lumbar vertebra assumes the form and size of a sacral vertebra, when it unites with the latter on one or both of its two sides, &c.

β. By the deficiency of some parts of the vertebræ. The most usual anomaly of this kind is a want of union between the right and the left halves, (*spina bifida*), which is observed by far the most frequently in the lumbar region, and exists in several degrees. The body itself is rarely divided into two parts. Generally the two halves of the arches are not united on the median line. This deviation of formation exists also in several degrees; for sometimes one portion of the lateral half is deficient, while the remainder is turned outward; sometimes there is simply a want of fusion between the two portions; and sometimes they are separated only by a small opening. Although, when spina bifida exists in a great degree, and is attended with an imperfect development of the spinal marrow and with an accumulation

serum within the vertebral column, it is met with in the lumbar region more frequently than in any other ; yet when the osseous system alone is affected, the first cervical vertebra furnishes the most numerous instances of this anomaly, and this from the want of union in its two lateral halves. This deviation of formation is symmetrical, and is rarely confined to one side of the body ; and then one semi-arch only is deficient.*

γ. *By the want of union between the posterior part and the body.* This is the slightest degree of the anomaly.†

δ. *By excess.* This includes the too great number of the vertebræ. One general law of this relation is that the superfluous vertebra is developed between and not at the side of the others. Here then the nature of the anomaly is determined by the rule itself. This anomaly, to which all our remarks of the contrary state apply, exists most frequently in the dorsal and in the lumbar regions. It is probable, however, that we cannot divide this into total and partial, and that when supernumerary vertebræ seem to exist, this anomaly is generally included in the class of anomalies in regard to quality.

§ 503. B. Of the *anomalies in regard to quality.* We may consider as such,—

a. An unusual mode of development in the vertebræ. Sometimes certain parts of these bones arise from special nuclei. This is true, in certain cases, of the spinous processes ; we have already remarked it of the atlas (§ 487). Bichat also states that he has seen this anomaly, but does not refer to any particular vertebra. Probably we must attribute to it, at least sometimes, those cases in which the vertebræ are composed of an unusual number of pieces of bone, united either by a broad cartilage or by ligaments, which permit them to play upon each other. Thus we have found the whole or a part of the spinous process‡ or of the transverse process§ forming a distinct bone. The former is seen in the second cervical vertebra, and the second is met with more particularly in the lumbar region.

b. The abnormal change of one vertebra into another. This head includes, to a certain extent, the preceding anomaly, especially the appearance of the transverse processes as separate pieces of bone ; because it refers the formation of the vertebræ, properly so called, to the laws of the development of the sacrum (§ 492). This resemblance seems more just because all the examples of this anomaly found in authors have occurred in the lumbar vertebræ, where it has been seen, moreover, three times by Ungebauer and twice by Rosenmüller.

The vertebræ may also present characters differing in another manner from those which belong to them in their normal state. This head includes the enlargement and the increase in volume of the last lumbar

* Rosenmuller, *De singul. et nativ. ossium corp. hum. varietatibus*, Leipsic, 1804, p. 58.
† Rosenmuller, *loc. cit.*
‡ Kelch, *Beiträge zur path. Anat.*, Berlin, 1813, p. 7.
§ Ungebauer, *loc. cit.*, p. 257.—Rosenmuller, *loc. cit.*, p. 58.

vertebra, and particularly of its transverse processes; its firm articulation with the iliac bones;* its fusion, with or without this change, with the sacrum; † the fusion (which is sometimes original, and not produced by an external cause,) of the other vertebræ, for instance, of two dorsal, which assimilates them to the false vertebræ of the sacrum; the change of the first piece of the sacrum into a true (viz. into a lumbar) vertebra, by the narrowness of the transverse processes, the want of fusion with the second, and its mobility upon the iliac bones; finally, the change of true vertebræ into others, for instance, of the last cervical into a dorsal vertebra, by the absence of the vertebral foramen, the elongation of its tranverse processes, and sometimes even the want of union between the anterior roots and the posterior roots of the transverse processes and the body.

A general law in this respect is, that *the adjacent vertebræ are those which are most disposed to change into each other.* Hence perhaps why the spina bifida is so often seen in the lumbar region; for some analogy exists between this anomaly and the normal formation of the sacral vertebræ.

Another law, which is in fact less general, is that *the corresponding vertebræ at the two extremities of the vertebral column tend the most to change into each other.* This law is supported by the want or union between the two semi-arches, of which the first cervical vertebra furnishes so many instances, and the numerous cases where the body of this, of the second, and even of the third cervical vertebra is found formed of several pieces, of which the lateral correspond to the anterior germs of the transverse processes of the sacral vertebræ.

c. Various other deviations from the normal formation. Such, for instance, as the obliquity of the vertebræ, arising from the body being higher on one side than on the other. When this anomaly is not corrected by an inverse arrangement of the adjacent vertebræ, there results from it a greater or less obliquity of the vertebral column. This arrangement is usually the first degree of the partial defect of a vertebra; for the side of the oblique vertebra which is least elevated is lower than usual, while the other side is not higher than usual.

II. ON THE ACCIDENTAL DEVIATIONS OF FORMATION.

§ 504. *a.* The most common of all the accidental deviations of formation, which are rarely congenital, is the *curvature* (*curvatura*) of the spine, of which we have three species, according as the column is curved *backward* (*cyphosis*), *forward* (*lordosis*), or *laterally* (*scoliosis.*) The first is the most common, the second the rarest. We may establish, as a general law, that a greater or less portion of the deformed vertebræ is destroyed on the concave side, that they are generally fused together on this side, and that the different kinds of curvature are most

* Kelch, *loc. cit.*, p. 7.
† Albinus, *Ann. acad.* book iv.—Van Doeveren, *Obs. acad.*, p. 206, 7.

common in those parts where in its normal state the vertebral column is bent in the same direction (§ 475). This deformity necessarily shortens the trunk in proportion to the loss of substance experienced by the vertebræ. We not unfrequently find curves in several directions at the same time, especially in the first and second. The vertebral column also not uncommonly presents two curves, but in opposite directions, thus preventing in some measure the obliquity of the body, which is otherwise unavoidable.

b. The *fusion* of the vertebræ together, when not congenital and not dependent upon a curvature, rarely occurs, except in extreme old age. The bodies are very rarely fused, or united into one, by the ossification of the fibrous ligaments. Most usually they are connected to one another externally, on their anterior face, by means of a bony substance developed between them. We sometimes find the sacrum united with one and even with both of the ossa ilia.

c. *Fractures* of the vertebræ are very rare, and require considerable force, because the vertebral column is composed of a great many bones articulated so as to move slightly upon each other. These fractures are almost always in a transverse direction.

d. From the same cause *dislocations* are very rare, unless they result from caries of the bones and the destruction of their ligaments. Hence why we often find dislocations of the vertebræ attended with union in a greater or less extent. Farther, these injuries are seldom seen, except in the most moveable cervical vertebræ, and particularly in the first.

CHAPTER II.

OF THE ACCESSORY BONES OF THE TRUNK, OR OF THE STERNUM AND THE RIBS.

I. OF THE STERNUM.

A. NORMAL STATE.

§ 505. The *breast-bone* (*sternum, ossa pectoris, xiphoïdes*)* is situated, like the vertebral column, on the median line of the body, directly under the skin, and opposite the spine. It forms the central anterior part of the chest, in the same manner as the spine forms its central posterior part. It may then be justly regarded as an anterior vertebral column.† This anterior vertebral column when perfect is composed

* See an excellent memoir of G. F. St. Hilaire, on "*Le sternum considéré dans les quatre classes d' animaux vertébrés, et sur la détermination philosophique des pièces dont il se compose*," in his *Philosophie anatomique*, vol. i. p. 17, 1818.

† We have collected in our *Memoir on the analogy of animal forms* many arguments drawn from comparative anatomy and from the history of the development of the fœtus which favour this opinion (*Beyträge*, vol. ii. part 2).

of three pieces placed perpendicularly, and called, the first, the *superior* sternal bone, or the *handle;* the next, the *central,* or the *body;* and the third, the *inferior,* or the *xiphoid* or *ensiform appendage* or *process*.

a. PERFECT STATE.

§ 506. This anterior vertebral column, or the breast-bone, is elongated, its length exceeding its breadth and also its thickness. Its upper end is much broader than its lower end. The bone does not grow narrower regularly, but becomes broader in the middle, after which it contracts again, and finally terminates in a point. Its anterior face is slightly rounded, and the posterior is also a little concave.

§ 507. The sternum is placed between the two clavicles and the seven pairs of ribs. The handle is the broadest and thickest part, the body the longest, and the xiphoid process the smallest in every dimension.

§ 508. The *handle* (*manubrium*) extends from the upper edge to where the cartilage of the second rib unites to the sternum. We remark, at the upper edge, on each side, a broad, oblong, cartilaginous cavity (*cavitas clavicularis*), where the sternal extremities of the clavicles are attached. Between these two cavities is a much smaller semicircular fissure (*incisura semilunaris*). The lateral edges converge from above downward; they are slightly concave and sharp in almost their whole extent, except at their upper and usually the thickest part, where they are broad, and hollowed out to receive the cartilage of the first rib. Hence each of the two edges is divided into a superior and an inferior fissure.

§ The *body* (*mucro, corpus*) extends from the inferior extremity of the handle to the insertion of the cartilage of the seventh rib. Its form is the reverse of that of the handle, that is, it is narrower at its upper than at its lower extremity, and rounds off at its termination.

Its lateral edges usually present four *semicircular grooves* (*incisuræ semilunares laterales*). At each of the places where these grooves are fitted to each other, we perceive *a small cartilaginous articular cavity* (*sinus articularis costalis*), which receives the cartilage of a rib. These grooves approach each other as we proceed downward; hence the articular cavities approach also. The third, fourth, fifth, and sixth costal cartilages are united to the sides of the body alone; the second articulates with it and with the handle; the seventh is also attached to its lower edge, and slightly to the upper part of the xiphoid process; the sixth and seventh are so near each other, that it is only in a very narrow and very elongated sternum that we can perceive a fifth and very small semicircular fissure between the articular cavities designed for them.

§ 510. The *xiphoid appendage* (*processus xiphoïdes*) unites at its upper edge to the lower part of the body. It is usually loose, but is sometimes covered by the cartilages of the sixth and seventh ribs,

which rise before it to go to the body, in which case the last attaches itself to its anterior face. Its lateral edges are free in most of their extent. Its inferior extremity remains cartilaginous (*cartilago xiphoides*) until the most advanced age; it terminates by a summit which is sometimes single, sometimes divided into two generally asymmetrical points.

b. DEVELOPMENT.

§ 511. The three pieces of the sternum,* the *handle*, the *body*, and the *xiphoid process*, are usually separate at puberty. We have observed the xiphoid process united with the body more frequently than the body with the handle. Sometimes, however, especially in old subjects, we find the three pieces fused into one bone.

The development of these bones varies much. As the trunk does not close anteriorly till very late, so the sternal bones do not appear early. From the fifth to the sixth month of pregnancy, we cannot perceive any points of bone in their broad cartilages. At this period the first germ shows itself usually in the handle, while the other two pieces present as yet no traces of ossification.

This nucleus of bone is generally single, oblong, and rounded; sometimes, however, we find two, almost always situated one above the other, the superior being much larger than the inferior. When the single nucleus is not oblong and rounded in the full-grown fœtus or after birth, but has the form of the figure 8, we have reason to think that there were two primitive nuclei, one above the other. It is much more rare to find two lateral germs arranged in such a manner that sometimes one is larger than the other, which then seems to be only an auxiliary piece, or they are both equal in size, and are perfectly symmetrical.†

It is less unfrequent to find more than two osseous nuclei in the handle. Albinus has seen three in one subject, situated one above another, the lowest of which was very small;‡ he also found in another individual four, one superior, occupying the breadth of the handle, and three inferior, a middle and two lateral.§

As the osseous nuclei of the handle appear before those of the other parts of the sternum, they are also of course much larger than the others when the other parts of the sternum have begun to ossify. Of forty cases now before us, there is only one exception to this rule, a fœtus of eight months, in which the handle presents two nuclei of bone, situated one above the other; the superior is smaller than the inferior

* Beclard has sometimes observed in the breast-bone of adults two pisiform osseous points, placed one on each side, on the tracheal groove of the sternum. He calls them *super-sternal*, or *pre-sternal*. See *Nouv. Journ. de méd.*, vol. viii. 1820, p. 8.i. F. T.

† We know of but one instance of this arrangement, which is described and figured in our *Beyträge*, vol. ii. part i. p. 145, plate 1, fig. 8.

‡ *Loc. cit.*, p. 87.

§ *Loc. cit.*, p. 92.

(which is another anomaly equally curious,) and both are not so large as the smallest of the three ossous germs.

After the seventh month we begin to perceive, in the body of the sternum, osseous nuclei, which present several differences. In fact, they vary much in number, size, and situation. They are developed at the side of each other more frequently than those of the handle, and almost symmetrically; for of thirty-three sternal bones of fœtuses and young children, we have found only nineteen in which the nuclei of bone were placed one above another. In eight of them the superior nuclei are single and unmated, and the inferior double, forming sometimes only one and sometimes several pairs. But in the other six, all the nuclei of the body are arranged in pairs, not, however, perfectly symmetrical in respect to size or situation; the single are the most rounded, and the pairs are more elongated and smaller than those which are single, and hence each of them resembles only one half of a single one; on this point our observations agree with those of Albinus.

The osseous nuclei, whether single or many, are always arranged so as to fall between two articular surfaces of the costal cartilages, whence it follows that one nucleus of bone is always developed between two ribs.

Usually, at least in all those cases we have now before us, when the osseous nuclei are situated over each other, we find only one between two costal cartilages. The observations of Albinus lead to the same result; for this anatomist states that even when he has found several nuclei in an intercostal space, they were always placed one at the side of another.

The superior nuclei are usually developed before the inferior; hence they are larger than the latter, although subsequently the body of the sternum is broader at its inferior part.

We often find in the fœtus at birth four osseous nuclei in the body of the sternum, viz., in the intervals of the second and third rib, of the third and the fourth, of the fourth and the fifth, and of the fifth and the sixth; but sometimes we find three only, and more rarely two. These differences arise from two causes: sometimes, but least commonly, the third and fourth osseous nuclei are fused into one which is larger; sometimes, and this is much more frequent, the fourth and even the third do not exist. In the last two cases, particularly when the third osseous nucleus is also wanting, it often happens that those which exist are divided—a remarkable coincidence, as it shows but little energy in the formative act.

In the xiphoid appendage a single rounded osseous particle only is generally developed, and we rarely find two* which are not symmetrical. The nucleus first appears at the upper part of the appendage; it gradually extends towards the base, but very seldom through the whole cartilage. Sometimes it is found even in the mature fœtus, but, generally, it is not developed till after birth, sometimes even very

* Albinus, *loc. cit.* p. 80.

late, not until the age of twelve, which is however abnormal, as in most subjects it is found before the expiration of the first six months.

The fusion of the four osseous nuclei, or of the four pairs of nuclei, of which the body of the sternum is usually composed at birth, commences with those which are placed at the side of each other. We have observed, at least, in examining the skeletons of old persons in which there are two lateral nuclei of bone in the same interval, that all those found above each other are still separate. The first which are fused together are the inferior two, so that the seventh, sixth, and fifth costal cartilages are entirely, and the fourth is partly attached to this piece of bone. The body is then formed of three pieces of about the same size, or of which, in old subjects, the inferior is much larger than the other two; but the two upper primitive pieces are still entirely distinct from the lower, which is formed by the union of the third and fourth. The second unites with the last more late, while the first continues separated and is not fused till puberty, at which time the sternum is composed of only three bones, the *handle*, the *body*, and the *xiphoid process*, which are not usually joined together till at a very advanced period.

The sternum then gradually develops itself by osseous pieces, which, as long as they are not fused together, have the greatest analogy with the last false vertebræ, those of the coccyx, and which, like the latter, bothin form and in their mode of articulation with the ribs, represent only the bodies of the vertebræ. It is easy, especially in the sternum of several animals, to demonstrate a cervical, dorsal, and lumbar portion; and as the nuclei of its middle portion become a single piece long before puberty, as all the parts fuse together and form only a single bone, so, too, the false vertebræ of the sacrum always, and the true vertebræ frequently unite in a single bone, while on the other hand in all the mammalia, the osseous nuclei, or the vertebræ of the sternum, one of which is always found between two ribs, remain separate and distinct through life.

§ 512. The sternum in the female is generally proportionally longer and narrower than in the male. The handle also is often, but not always proportionally larger and broader in the female than in the male.

The sternum is articulated, in the points mentioned, with the clavicles and with the cartilages of the seven upper ribs.

B. ABNORMAL STATE.

§ 513. The most abnormal state of the sternum is its entire absence, with or without a similar deficiency of the common integuments, and of the ribs: in the former case the heart is seen naked, in the latter it may be felt beneath the skin.* A modification of this state is the existence of openings which exist most generally at the lower part of the body of the bone, or in its xiphoid appendage, or the fissure of this

* Wiedemann, *Ueber das fehlende Brustbein*, Brunswick, 1794.

appendage. It is remarkable that these openings are found only at the lower part of the body and in the xiphoid appendage,—another argument in favour of the parallel between the vertebral column and the sternum, since spina bifida is seen more frequently in the lower part of the spine, the lumbar vertebræ, which corresponds to the lower portion of the sternum. The sternum is sometimes too short. This defect in formation is generally attended with the imperfect development of the chest. Then, generally, the bone is much *broader* than usual, and more or less arched forward.

It is less common to find the sternum longer than usual, which is also curious, as furnishing another character of analogy between the anterior and the posterior vertebral column.

II. OF THE RIBS.

A. NORMAL STATE.

I. PERFECT STATE.

a. General characters of the ribs.

§ 514. The *ribs* (*costæ*) are twelve pairs of thin bones; their length exceeds their breadth; they are slightly arched, convex outward, and concave inward, and are situated on the two sides of the chest, and form most of its bony parietes; and they extend from the vertebral column to the sternum which they unite, allowing them to play on each other.

§ 515. All the ribs present the following general characters:—

They all terminate backward in a round *head* (*capitulum costæ*), which is faced with cartilage. They are formed more or less perceptibly by the union of the segments of two different circles, that to which the posterior part belongs being much smaller than the anterior, and both of which run into each other very gradually. The ribs are broadest where these two circles meet, and their inferior edge often projects into a line, termed the *angle* (*cubitus*). Their posterior extremity, which is of a rounded square form, is thicker, firmer, and narrower than the anterior, in which direction they become flatter, and evidently present two faces and two edges. The upper edge is usually slightly rounded, and the lower is sharp. In most of the ribs the internal face, near the lower edge, and at the back part, becomes thinner and presents a groove, called the *costal groove* (*sulcus costarum*). Towards their anterior extremity, the ribs gradually become thinner, and terminate by a slight, but not oval prominence. Most all of them present externally, behind the place where the posterior circle is confounded with the anterior, an elevation covered with cartilage, and called the *tubercle* (*tuberculum costæ*). The part between the head and the tubercle, which is usually contracted, is called the *neck* (*cervix*, *collum*); the rest of the bone, that is, its anterior portion, is called the *body*.

The ribs are articulated by their heads, which are covered with cartilage, with the *lateral articular facets* (*facies articularis lateralis*) (§ 485) of the bodies of the twelve dorsal vertebræ, and by their tubercles, with the *transverse articular facets* (*facies articularis transversa*) (§ 483) of the transverse processes of these same vertebræ. At their anterior extremities, we find the *costal cartilages* (*cartilago costæ*).

The direction of the ribs is such that their posterior extremities are always higher than their anterior.

The situation of the ribs, and their relations with the dorsal vertebræ, prove, that they may be regarded only as a greater development of the anterior roots of the transverse processes of these same vertebræ ; and their cartilages may be considered as imperfect ribs of the sternum.

b. Of the differences of the ribs.

§ 516. The ribs differ, 1st, in their size ; 2d, in their curve ; 3d, in their direction ; 4th, in their form, and in the relations of their constituent parts ; and, 5th, in their attachments.

1st. The ribs increase in size after leaving the two extremities of the chest. The first and the twelfth are the shortest. They increase from the twelfth to the seventh, and from the first to the sixth. The sixth and the seventh are about equal in length, and are longer than all the others.

But although the first and the twelfth are almost equal in length, the mass of the latter is much less ; it is much thinner than the other. The twelfth rib is much shorter than the first ; besides, its size varies much more than that of the first.

2d. The *curve* diminishes considerably from the first to the twelfth : the second, however, is usually more curved than the first. The inferior ribs are very flat ; the twelfth is sometimes straight. Whatever may be the case in respect to the proportional size of the curve, the first and the twelfth are similar in their curve, as their composition by two segments of circles of different areas, is less evident than in the others. This arrangement is seen particularly in the last.

3d. The ribs descend much less from behind forward according as they are more superior. At the same time, the upper ribs have one of their faces turned upward, the other downward, one of their edges turned inward, the other outward ; while, in the lower ribs, the edge which is internal in the others, is directed upward, and that which is external downward ; the upper face outward, and the lower face inward, so that the ribs seem turned on their axes.

The direction of the costal cartilages also varies. That of the first rib follows the direction of the bone, and descends obliquely to the sternum : that of the second, is perpendicular to it. All the others ascend, their inclination upward increasing as we descend, except the last, the anterior extremity of which is unattached.

4th. The ribs differ in several respects in respect to their form.

a. The proportion of the neck to the body varies. The neck is pro-

portionally longer as the rib is situated higher up, although its absolute length increases from the first to the eighth rib. The neck of the ninth rib is not generally much longer than that of the first, although the latter is very short; that of the succeeding is still shorter. The last two which have no tubercle, have likewise no neck. At the same time, the tubercle projects the more the higher the rib is. As it enlarges, we most generally see developed two surfaces covered with cartilage, an interior and superior, and a posterior and inferior, which unite to form an angle; and which, often, particularly in the upper ribs, with the exception of the first, are separated by a depression which has no cartilage. In the inferior ribs, this tubercle projects less, and has only a plane surface; and in the last two ribs it is entirely deficient.

b. The grooves and angles (*cubiti*) formed at the union of the anterior and posterior segments, are much more distinct and much longer from the third rib to the ninth, than in the others; and the length of the posterior segment, between the head and the angle, increases considerably from above downwards.

c. The first rib is the strongest, and especially the broadest, not only in proportion to its length, but positively. Its upper surface is more rough and uneven than any other.

5th. In respect to their attachments, the ribs vary in three different modes:—

a. They differ in their manner of articulation with the dorsal vertebræ; and here we have two different cases:—

α. The ten, sometimes only the nine upper ribs, or even the first eight, are attached by their heads to a deep articular surface, forming a re-entering angle, and hollowed from the two nearest dorsal vertebræ. The others are received in a single round and convex articular surface of a single vertebra.

The form of the head also varies, having two surfaces united at a projecting angle in those ribs which are attached to two vertebræ, while in the others it has only a slightly convex surface.

β. The ten upper ribs only are articulated by a tubercle, with the summits of the transverse processes of the corresponding dorsal vertebræ. The last two are not arranged in this manner, and their posterior extremities are not connected, except with the bodies of the vertebræ.

b. Neither are all the ribs united by their anterior extremities with the sternum, in the same manner.

Here, also, we have two different cases.

α. All the costal cartilages do not extend to the sternum. Those only of the upper seven ribs are attached to this bone, being fixed in its articular cavities (§ 509) by ligaments. The thin cartilages of the last five do not arrive at the sternum, but are only attached to the cartilage above. This is not, however, the case with all, as is seen in the twelfth, and sometimes the eleventh; but their anterior extremities remain unattached, and they are connected with the other ribs only by the intercostal muscles, and by the broad abdominal muscles. On this is founded the distinction into *true ribs* (*costæ veræ*) and the

false ribs (*costæ spuriæ*). The upper seven are the true ribs, and the other five are the false ribs.

β. The cartilages of the ribs have not the same length. Like the ribs, they increase in length from the first to the seventh, and then diminish from this to the last.

c. The ribs differ in respect to their connections with each other. While the superior six are not united, the cartilages of the sixth, seventh, eighth, ninth, and tenth are joined together. Of the last, the upper are usually united by the prolongations of the upper cartilage, which correspond to the depressions in the upper edge of the cartilage below, and which are kept in place by capsular ligaments. This is not the case with the last, which are simply applied to one another.

§ 517. The differences between the ribs, principally the greater length of the neck, the angular form of the articular surface of the head and of the tubercle, the greater projection of the latter, the diminution in length, and increase in breadth of the costal cartilages, and, finally, their connections with the sternum, by its anterior extremity, demonstrate this important proposition—*that the ribs are less moveable the higher they are situated, and that their mobility diminishes very much from above downward.*

II. MODE OF DEVELOPMENT.

§ 518. The ribs are among those bones which are formed and developed the first. From the beginning of the third month of fœtal existence, their osseous portion is, proportionally speaking, as large as when fully developed. They arise, however, from three points of ossification ; for the head and tubercle have each a nucleus, which begins to appear at the age of sixteen years, and is soon fused with the remainder of the bone. These nuclei do not exist in the two or three lower ribs.

III. SEXUAL DIFFERENCES.

§ 519. The ribs of the female are generally straighter than those of the male. The posterior segment unites sooner with the anterior ; its curve differs less from that of the last, and disappears sooner in the female ; hence the chest is narrower. The ribs are usually thinner ; hence the edges are sharper. Sometimes, however, this is far from being true. Their length is nearly the same : but we are satisfied from numerous observations that, in general, the length of the two upper ribs is proportionally, and when the subject is short, *absolutely* greater in the female than in the male.

B. OF THE RIBS IN THE ABNORMAL STATE.

§ 520. The ribs present four different anomalies.

I. The primitive deviations of formation, which are very interesting, belong, almost all, to the class of anomalies in regard to quantity.

§ 521. The deficiency in formation is seen :—

a. In less than the usual number. As a general rule, we say, that there is seldom or never deficient more than one rib on each side; that this is never the upper, but the last; that one on each side is deficient, more commonly, than on one side only: finally, that the absence of a rib is attended, or not, with the absence of a vertebra. Sometimes only a costal cartilage is deficient, and then two ribs are inserted in the same cartilage.

b. In their shortness. The lower ribs, particularly the twelfth, are those which are unusually short, either on one side or on both; so that they seem only as small vertebral processes. Sometimes these bones have the usual length, but are very slightly arched, which establishes a resemblance with most of the mammalia, and generally, with most animals in which the cavity of the thorax is almost always narrower than in man. This deviation of formation is generally confined to some ribs. In some cases this anomaly extends to all, either on one side, or on both sides; and then, sometimes, the ribs do not reach the sternum: and sometimes they are connected with this bone, as usual. When the latter case occurs, the cavity of the chest is very much contracted.

c. By imperfect ossification, whence the ribs are sometimes divided in a part of their length by a cartilage, as in birds; or the costal cartilages are more or less deficient, so that the ribs are not connected with the sternum, as in the lowest reptiles and in the fishes. The least and the most common degree of this anomaly is that which consists in the shortness of the cartilage of the seventh rib; by which arrangement the number of the false and of the true ribs is equal.

§ 522. The excess of the formative power is seen in a still different manner in the ribs.

a. The slightest degree is an abnormal length and height of the ribs, or of their cartilages, or of both, which is seen in some ribs only more generally than in all, and exists on one or on both sides. We not unfrequently find the anterior extremities of these bones much broader than usual, which *gradually* leads to an increase of their proper number. Their enlargement establishes an analogy between man and many animals, especially the pachydermata and the myrmicophaga, among the mammalia, and the chelonia among the reptiles.

The prolongation of the cartilage of the eighth rib increases the number of the true ribs to eight, as in apes.

b. A greater degree of this anomaly is a division of the ribs which always commences at their anterior extremity; we have never seen them divided into an internal and external piece, but always into a superior and an inferior process. This last arrangement may also be construed into a general rule, the more important as it seems to indicate that nature imitates the fundamental type even in her anomalies, as we have before shown when speaking of the vertebræ. The two processes rarely have the same length. When the deviation of formation exists in a slight degree, the ribs close before the fissure, so that only a small opening is seen. When existing in a greater degree, one of these two prolongations is united with the cartilage, and when

more anomalous, both are connected with it. The cartilage of the rib then is sometimes single, and only broader than usual and sometimes divided partially, or in its whole extent, on the side of its posterior extremity; this last anomaly may also exist without a division of the ribs, which may be broader than usual. In this case, the cartilage is broader than usual, or an opening penetrates through it; or it may be bifurcated at one or the other extremity, and finally it may be entirely double, and then its posterior part is unattached or united to a rib.

Another result of an excess in the development of the ribs is the formation of processes at their posterior part, particularly near the tubercle. This anomaly may exist in several degrees. Sometimes the process does not extend to the adjoining rib; sometimes the two ribs unite either by a single process of a certain length belonging to only one of them, or by the union of a process from two ribs; sometimes even there is a distinct bone between the two prolongations. This arrangement not unfrequently causes the fusion of two or more ribs, which fusion takes place usually at their posterior part. The former case is similar to the formation of birds and the latter to that of the chelonia. The upper costal cartilages are sometimes united in a similar manner by prolongations or unusual processes.

c. The redundance of the ribs, to which their division and increase in breadth gradually lead, differs in regard to the situation, the number, the size, and the attachments of the supernumerary ribs.

α. The supernumerary rib usually forms below the twelfth and not above the first, in which case the number and the arrangement of the upper ribs and the cervical vertebræ are the same as usual, while there is one dorsal vertebra too many, or at least the inferior ribs are only a little more developed. This supernumerary rib is sometimes found above the first; in this case, it generally arises from the anterior root of the transverse process of the seventh cervical vertebra, which is unusually developed and which is not united to the rest of the bone; the first rib is then generally longer and thinner than usual.

The increase in the number of the lower ribs is similar to the formation of the mammalia, and that of the upper to what is seen in birds.

β. Number. 1st. The number of the ribs may be increased on one side or on both.

2d. We may find one or more supernumerary ribs on one side or on both at the same time. We generally find a supernumerary rib on one side only, which, by a double fissure, apparently increases the whole number of ribs to fifteen; but we find a supernumerary pair of ribs more commonly than one supernumerary rib.

γ. The size of the supernumerary ribs varies much. They are generally very small, and appear only as imperfect rudiments. The first degree of this anomaly at the top of the chest, is the unusual prolongation and sharpness of the transverse process of the seventh cervica

vertebra, below, at the bottom of the thorax, the existence of a moveable little bone in the transverse process of the first lumbar vertebra.

δ, The mode of union also varies. The lower supernumerary rib unites no more than the twelfth with the cartilages of the ribs above it. The superior is also almost always free, as are the upper ribs of several birds and reptiles; but when it is more developed, its anterior extremity unites to the body of the one next to it, the first properly speaking, and when still longer, it may extend to the cartilage of the first rib, or may have a proper cartilage, going directly to the upper bone of the sternum.

§ 523. 3d. The anomalies in regard to *quality* are—

a. A too slight curve, the straightness of the ribs without any shortening.

b. Being curved in such a manner that their convexity is turned inward and their concavity outward.

c. The insertion of the anterior or of the posterior extremity of one or more ribs above or below, before or behind the usual point. This arrangement sometimes exists on one side only, and sometimes on both sides at the same time, either in regard to one rib, or several; but it is less important and less curious than the first two kinds of anomalies.

§ 524. II. The accidental deviations of formation of the ribs, offer nothing peculiar. From their mobility and the difficulty of fixing them permanently, it often happens that false joints are formed in them by fractures.

SECTION II.

OF THE BONES OF THE HEAD.

A. NORMAL STATE.

§ 525. The series of true vertebræ, those which are moveable upon each other, terminates below in the sacrum, which is composed of five false vertebræ fused together; this column supports, at its upper part, the head, which is formed in a similar manner (§ 465). The cranium and face, which compose it, include numerous bones, which usually may be easily separated from each other at the period of puberty, although, with one exception, viz. the lower maxillary bone, they are articulated by sutures (§ 243) which admit of no motion. At this period, the skull is formed usually of seven, rarely of eight bones. In the face we number fourteen bones.

CHAPTER I.

OF THE SKULL.

A DESCRIPTION OF THE INDIVIDUAL BONES.

§ 526. The bones of the skull, regarded from below upward and from behind forward, are the *basilar bone* (*os basilare*,) the *temporal bones* (*ossa temporum*), the *parietal bones* (*ossa parietalia*), the *frontal bone* (*os frontis*), and the *ethmoid bone* (*os ethmoiedum*). Many of these are very similar to entire vertebræ, or to the parts of vertebræ. Most of them are flat altogether or in part (§ 234), concave internally, and convex externally. They unite and enclose a considerable cavity. One face presents *elevations* and *depressions* (*fossæ, et eminentiæ*, s. *juga digitalia, cerebralia*), similar to those produced by the finger in a soft mass, and which resemble the external surface of the brain. Most of them are developed by several points of ossification.

I. OF THE BASILAR BONE.

§ 527. The *basilar* bone (*os basilare*) was first described as a single bone by Sœmmerring. Its anterior portion corresponds to the *sphenoid* bone (*os cuneiforme*, s. *sphenoideum*, s. *alatum*, *pterygoideum*, *multiforme*, *polymorphon*), and its posterior portion to the *occipital* bone (*os occipitis*), which are generally described as separate bones, because they are separable from each other in the skulls of young subjects; but as they are found fused together when the other bones of the body are perfectly developed, and as the different parts of which they are composed are then united and blended, Sœmmerring's opinion is more correct than that of those who preceded him.* The basilar bone may then be termed also the *spheno-occipital* bone (*os spheno-occipitale*).

§ 528. The basilar bone occupies the inferior, middle, and posterior part of the skull. It is so wedged in between the other bones of the skull, that it articulates with all. Although it should be considered as one bone, the best way of describing it is to distinguish it, as is generally done, into two portions, the anterior, or the *sphenoid* bone, and the posterior, or the *occipital* bone.

* *Knochenlehre*, p. 109.—Spix attributes this opinion to Mondini, and blames it (*Cephalogenesis*, Munich. 1815, p. 16); but we think he is wrong in both respects. Mondini, it is true, speaks (*Anat.*, Marburg, 1510, p. 48. 57) of a *basilar bone* of the head; but he expressly considers the occipital bone as a separate bone, and understands by the term *basilar* the sphenoid, the temporal, and the ethmoid bones; so that he counted only five bones in the skull. On the other hand, as the sphenoid and the occipital bones are always fused together, even before all the bones are perfectly developed, we cannot consider them as two distinct bones, at least in man, although they are always distinct in most animals, for then we could not regard the sphenoid bone as a single bone with any more propriety.

a. OF THE OCCIPITAL BONE.

§ 529 The *occipital* bone (*pars* s. *os occipitale*) forms the lower and posterior portion of the basilar bone, and appears in every respect as an enlarged vertebra. Like all the vertebræ, it presents a ring composed of a thicker anterior portion and a thinner posterior portion ; the latter however is much more developed, is absolutely and relatively broader and higher than in the other vertebræ, while the anterior is at least smaller than the bodies of the dorsal and lumbar vertebræ.

§ 530. We distinguish, in the occipital bone, the *basilar* portion (*pars* s. *processus basilaris*), the *condyloid* parts (*partes condyloideæ*, s. *jugulares*), and the *squamous* portion (*pars squamea*).

§ 531. The *basilar* portion corresponds to the bodies of the other vertebræ, and consequently should be called the *body*. It is the most anterior, the smallest and the narrowest portion of the bone. In form it is an irregular hexagon, broader backward and downward, and thinner forward and upward. The middle part of its posterior edge is jagged, and forms the anterior edge of the occipital foramen. The two posterior lateral edges are inclined from behind forward and from within outward, and are blended with the anterior edges of the condyloid portions. The two anterior lateral edges converge towards each other forward. Its transverse anterior face is covered with cartilage, and when the basilar bone is perfectly developed, it is fused with the centre of the sphenoidal portion.

The upper or posterior face of the body strongly inclines from before backward, which depends particularly on the considerable thickness of the anterior portion. From one side to the other is a deep depression, called the *fossa of the medulla oblongata* (*fossa medullæ oblongatæ*). The line of demarkation which separates it from the anterior lateral edge is generally marked by the *furrow of the posterior petrous sinus* (*sulcus sinus petrosi posterioris*). The inferior or anterior face is straight in comparison with the preceding. When, however, the skull is in its natural situation, it ascends from behind forward. We remark there, on the median line, a projection from before backward, called the *basilar crest*, or *spine* (*crista*, s. *spina basilaris*, s. *pharyngea*) ; or the sides, two transverse symmetrical elevations ; and behind these, several depressions. At its most posterior portion, it assists a little in forming the anterior extremity of the occipital condyles.

§ 532. The *squamous* portion forms the posterior and lateral parts of the occipital bone. It is thin, flat, broad, and curved in its upper and posterior portion which is the most considerable ; and in its inferior and anterior part, which is the smallest,—uneven, thick, and irregular. The latter corresponds to the anterior part of the arch of the vertebræ, which supports the transverse and articular processes ; the former, to the posterior part of the same arch, in the middle of which is the spinous process directed backward. The second is the proper *occipital* portion of most anatomists ; the other embraces the *condyloid*,

articular, or *jugular* parts (*partes condyloideæ, articulares, jugulares*) of authors.

§ 533. The *condyloid* or *articular* portions are narrower and thicker forward, and backward they are broader and thinner. Their faces and edges are very uneven. On the upper face, where it joins the basilar portion, is a protuberance called the *jugular tubercle* (*tuberculum jugulare*) Backward and outward is a considerable furrow, which proceeds from behind forward, and from without inward ; this is called the *groove of the transverse sinus* (*sulcus sinus transversi*). Between this furrow and the process is the anterior opening of the *posterior condyloid canal* (*canalis condyloideus posterior*).

On the inferior face we notice a convex eminence, the *condyloid process* (*processus condyloideus*) which is directed from behind forward and from without inward. Before, above, and on the outside of this eminence, is the external opening of the *anterior condyloid canal* (*foramen condyloideum anterius*). Directly behind its posterior extremity is the posterior opening of the *posterior condyloid canal* and the *condyloid fossa* (*sinus condyloideus*). Behind and on the inside of this opening, in the circumference of the posterior part of the lateral parietes of the large occipital foramen, are well marked muscular impressions.

Internally, the articular portion is broad before, and presents an inner surface inclined from above downward and inward. Its internal edge is uneven. It forms the lateral wall of the large occipital foramen. Behind and below the jugular tubercle, it presents the *internal orifice of the anterior condyloid canal.*

The external edge commences by the *large jugular* fissure (*sinus jugularis*), at the extremity of the fossa of the longitudinal sinus. Next comes a small eminence covered with cartilage, and called the *jugular process* (*spina jugularis*), and then a slightly serrated edge (*margo mamillaris*).

Backward, the condyloid portion is continuous with the proper occipital portion.

§ 534. This last portion, which several anatomists, as Loder, contrary to all analogy, have called the *body*, curves from below and forward upward and backward. It is triangular, and seems formed of two portions, the inferior of which is broader than the superior, which unite at an obtuse angle.

The upper half of the external face is smooth, while the muscular impressions and the depressions render the lower half uneven. The upper circuit of the latter is formed by the *upper curved line* (*linea semilunaris superior*), which is convex above, and extends from one side of the squamous portion to the other. Towards the middle of the inferior portion is a second semicircular elevation, the *lower curved line* (*linea semilunaris inferior*), which extends as far as the preceding. This inferior half is itself divided into a right and a left portion, by a longitudinal eminence more or less distinct according to the individual, *the external occipital crest* (*crista occipitalis externa*), which always

begins with a greater and broader projection, termed the *external occipital protuberance* (*spina occipitalis externa*); this extends to the posterior edge of the large occipital foramen. The enlarged edge of the latter produces in some measure a third curved line, the *occipital crest* (*crista occipitalis*), concentric with the two preceding, and having the same uses.

The internal face of the squamous portion is divided by the *crucial ridge* (*eminentia cruciata*) into four nearly equal depressions. The upper half of the longitudinal branch of this eminence is the fossa of the termination of the longitudinal sinus of the dura mater (*sulcus longitudinalis*). The two transverse branches are the lateral fossæ (*sinus transversi*), which receive the lateral sinuses. The falx cerebelli is attached to the *internal occipital crest* (*crista occipitalis interna*), which is that part of the longitudinal branch situated below the intercrossing, and so called because it projects more or less, and is seldom grooved. The fossæ are bounded by two parallel elevations. They are rarely symmetrical: in fact, the lower part of the longitudinal branch corresponds exactly to the median line; the upper, however, rarely presents the same arrangement, so that the two lateral elevations, between which the fossa extends, descend at an equal distance from this line, and the centre of the fossa falls exactly upon it. The fossa more commonly separates to the right and left, and one of the edges descends along the median line; and not unfrequently the fossa extends to one side, so that its internal edge passes very far, sometimes even half an inch, beyond the median line; hence the defect in symmetry is much more evident. Most frequently, in two of every three cases, the longitudinal fossa goes to the right; hence the left transverse fossa is longer, but at the same time the right is broader. The latter is a direct continuation of the longitudinal fossa, while the left joins the two by an oblique fossa. It sometimes, though rarely, happens that one of the transverse fossæ follows the same direction as the longitudinal, so that the inferior extremity of the latter is uninterruptedly continuous with it; but then the transverse eminence, which is single, occupies its usual place, even so that when the longitudinal fossa is turned very much to the left, the upper half of the longitudinal eminences is found on the median line.

The cerebellum is situated in the inferior fossæ, which are hence called the *inferior occipital fossæ*, or the *fossæ of the cerebellum* (*fossæ cerebelli*). The superior fossæ receive the posterior portion or the lobes of the cerebrum; hence they are called the *cerebral* or *upper occipital fossæ* (*fossæ cerebrales*). The former are often smooth; sometimes, however, we find alternate elevations and depressions, which are convex above and concave below, forming a concentric, narrow, and plane series, which proceeds from the median line to the lateral edges. The digital impressions and mamillary eminences of the inferior fossæ are more rounded, straighter, broader, and more distinct.

At the place where the fossæ cross, the internal face of the squamous portion has a large projection called the *internal occipital protuberance*

(*spina occipitalis interna*). As this protuberance corresponds to one on the outside, the thickness of the bone is greatest in this place, being sometimes half an inch.

b. OF THE SPHENOID BONE.

§ 535. The *sphenoid* bone occupies the middle and a part of the anterior region of the base of the skull, and a small part of the lateral regions.

It is composed of a central portion, the *body*, and several *processes*, some of which are on the sides, and others below. This arrangement causes it to resemble a vertebra.

§ 536. The body is continuous posteriorly with the basilar portion of the occipital bone. Above this point it curves more or less upward and forward, so that the upper and unattached portion of its posterior face succeeds the upper part of the basilar portion (§ 530). This posterior face is very rough, and its upper edge is more or less prolonged, to give origin to the *posterior clinoid processes* (*processus clinoidei posteriores*).

The upper face is nearly always distinctly divided into three successive parts. The posterior part is grooved in a transverse direction, and forms the *sella turcica*, in which the pituitary gland is situated. The middle, which is smaller, ascends more or less obliquely from behind forward; it is most generally a little convex or plane, and is rarely grooved. It is the crossing-place of the optic nerves. The anterior is horizontal.

The anteriore edge of the upper face is serrated, and forms in its centre a large projection.

The lateral faces descend slightly from within outward. On the limit which separates them from the superior face is a groove, the *carotid groove* (*sulcus caroticus*), which lodges the internal carotid artery. Near their anterior extremity, or on the limit between the inner and the upper face, we see on each side a more remarkable projection, in which the line of demarkation between the middle and posterior portions of the superior face terminates; these are the *middle clinoid processes* (*processus clinoidei medii*). These processes sometimes unite, when largely developed, with the posterior and the anterior clinoid processes; the latter union is more common than the former, and is sometimes seen alone, while the former never occurs without it.

The anterior face, which is slightly convex, is not always formed by a plate fused with the rest of the bone, but often by two distinct pieces of bone, which are very thin, and are called the *sphenoidal horns* (*cornua sphenoidea*). It is always imperfect at its upper part, and presents in its centre a longitudinal eminence called the *sphenoidal crest* (*spina* s. *crista sphenoidalis*).

The under face is slightly grooved. Forward and in its centre it forms a small, thin, longer or shorter eminence, called the *sphenoidal beak* (*rostrum sphenoidale*).

The crest and the beak of the sphenoid bone are more or less continuous with each other.

The body of the sphenoid bone is formed in the adult of very thin walls, and is hollowed into two large cavities, the *sphenoidal sinuses* (*sinus* s. *antra sphenoidalia*), a right and a left, which are separated by a longitudinal partition, of which the crest and the beak are prolongations, and the surface of which is often increased by the projections which arise from it.

§ 537. The processes of the sphenoid bone are the *large wings* (*alæ magnæ*), or the *middle processes* (*processus medii*); the *small wings* (*alæ minores*), or the *superior processes* (*processus superiores*); and the *pterygoid* or *inferior processes* (*processus pterygoidei* s. *inferiores*).

§ 538. The *large wings* arise below from the lateral wall of the body. At first narrower, they become broader forward and backward, curve forward and outward, and terminate in an upper and a lower point. Their form is triangular. Their concave face, which is turned inward, is uneven (§ 535); the anterior, which is square and also turned inward, is almost straight, or rather slightly concave. The external is convex from above downward, and a little concave from before backward. The inferior, a continuation of it, is straight.

§ 539. The *upper*, or the *small wings*, are much smaller than the preceding, and are lateral projections of the anterior part of the upper face of the body. They arise by two roots, an anterior and superior, which is thin; a posterior and inferior, which is thicker. Their direction is forward and upward, but principally outward. They are flat and thin, convex and sharp before, concave and thicker behind, and terminate outward in a free point. The inner circuit of their posterior edge, is a tubercle, called the *anterior clinoid process* (*processus clinoideus anterior*). This process is opposite the posterior clinoid process. It often unites with the middle clinoid process (§ 536); by which arrangement there is behind the optic foramen a second opening, situated at the anterior extremity of the carotid groove, and through which the carotid artery passes.

We less commonly find a third opening which results from the union of the middle and posterior clinoid processes.

It rarely happens that the anterior clinoid processes are united with the posterior, only by a long slip of bone.

All these anomalies occur on both sides more frequently than on one only.

§ 540. The *lower*, or the *pterygoid processes* detach themselves from the boundary which separates the inferior and lateral face of the body from the origin of the large wings, where the bone is thickest. They direct themselves from above downward, at the same time being inclined slightly outward. They divide posteriorly, soon after arising, and even at the place of origin, into two thin layers, called the *pterygoid wings* (*laminæ pterygoideæ*), which are fused together in almost their whole extent forward. The internal, which separates

them behind, is termed the *pterygoid fossa* (*fossa pterygoidea*); at their lower part, they separate also from each other forward, thus forming the *pterygoid*, or the *pterygo-palatine notch* (*fissura pterygoidea*, s. *pterygo-palatina*).

The inner and longer layer terminates in a rounded hook turned outwardly, called the *pterygoid hook* (*hamulus* s. *uncus pterygoideus*). As this hook is the continuation of the posterior edge, and as the anterior edge is equally prolonged, although a little less so, there exists between them a more or less considerable furrow.

The external layer, which is the shortest, terminates much higher than the preceding. At its summit, it curves inward, under the inferior face of the body, with which it is often intimately connected. This reflected part is termed the *vaginal process* (*processus vaginalis*).

§ 541. In and between the different parts of the sphenoid bone are deep fissures, notches, and openings, through which the vessels, and especially the nerves, pass.

Between the two roots of the upper wing, we find the *optic foramen*, or more properly the *optic canal* (*canalis opticus*), which is short, rounded, and more broad than high.

Below this hole, between the upper and the middle process and the anterior part of the lateral face of the body, we remark a considerable irregular space of an elongated triangular form, broader inward and downward, and extending obliquely from without inward. This is the *sphenoidal fissure* (*fissura sphenoidea propria* s. *spheno-sphenoidea*). It is usually open externally, because the point of the small wing does not touch the upper edge of the large wing: but these two parts often touch, forming a true foramen.

The *foramen rotundum* is found in the root of the great wing, below this fissure; and it is separated from its inferior and posterior extremity by a small bridge of bone. It is a very short canal, which is continuous forward and backward with a semi-canal.

The posterior semi-canal unites more or less evidently with a much larger opening, near the posterior angle of the large wing. The direction of this is from above downward; it is situated much more behind and outward, and is called the *foramen ovale*.

Between the foramen ovale and the foramen rotundum, we sometimes find a much smaller hole, which also penetrates the large wing from above downward.

Directly behind the foramen ovale, and outside of its external extremity, the large wing is always pierced from above downward by another *foramen*, the *spheno-spinous* (*foramen spinosum*).

Finally, the *vidian* or the *pterygoid canal* (*canalis vidianus*) passes through the substance of the sphenoid bone to where the large and small wings are detached from the body, immediately below its division. Its direction is from before backward, from below upward, and from within outward.

§ 542. The history of the development of the basilar bone is very complex, because each of its two parts, which are still separate from

each other but a little time before the whole organism is perfectly developed, are successively formed by a considerable number of osseous nuclei.

§ 543. The occipital portion appears long before the sphenoidal portion. According to our researches, it is usually formed by eleven points of ossification, which gradually develop themselves; eight for the squamous portions*, the other three for the articular and basilar portions. The rudiment of the squamous portion begins to show itself at the second month, directly behind the large occipital foramen, in the form of a pair of triangular nuclei, separated in the middle. These two osseous pieces fuse together. At the same time, a second pair appears, situated upward, corresponding to them in form, and representing the upper half of the squamous portion; these also, at the fourth month, unite with each other, and also with the inferior part, except in the region of the jugular tubercle, where a sensible opening still remains. About the same period, we find a third pair, situated outward and upward, on the sides of the second: while this unites to the last, a fourth forms in the highest part, above the second. Thus the same formation is thrice repeated, until all the pieces are united, which most generally happens sooner or later, but sometimes never takes place. The squamous portion is usually formed at the fifth month. We, however, remark on each side of the fœtus at birth, frequently even much later, one suture extending from the upper extremity of the serrated edge, and following the jugular process, inward and upward; a second, which goes directly downward, from the upper extremity of the bone; and a third, which proceeds exactly upward from the lower edge of the squamous portion. These three sutures indicate that the squamous portion is composed of several pieces, which often remain insulated during life, and are then called the *wormian bones* (*ossa wormiana* s. *triquetra*).

The condyloid portions appear a little later than the squamous portion, but always earlier than its upper part. They first show themselves as small, single, oblong and rounded osseous nuclei. The middle basilar portion is ossified the last.

These four portions fuse together in the same order as that in which they were ossified. The squamous part is separated from the rest long after its different nuclei are united in a single bone. In the full grown fœtus the occipital portion is still formed of four pieces, of which the two condyloid portions are united before with the basilar portion, behind with the squamous part, but in no place with each other. This insulation remains even after birth, for we have seen it in a subject seven years of age.

As in all the vertebræ, the posterior part of the ring is developed the soonest, since the pieces of the squamous portion are first united,

* Without doubting the existence of four pairs of germs in the squamous portions of the occipital, or *proral* bone, Beclard asserts that this arrangement, far from being constant, should be considered a rare variety. He admits but four points of ossification in this portion. F. T.

then this portion joins the two condyloid portions, and these last three have long been united when the basilar portion is still entirely distinct. The marks of separation between the condyloid and the squamous portions disappear internally later than they do externally; the contrary rarely happens.

§ 544. The *sphenoid portion* ossifies much later than the occipital portion. The osseous nuclei first appear in the third month of pregnancy in its two large wings; next, one forms for each internal layer of the pterygoid processes. Afterwards, we see a third pair of osseous germs in the circumference of the small wings; then, at the age of eight months, a seventh and eighth nucleus which are fitted to one another in the body. At five months, a fifth pair forms near this fourth pair, between it and the large wing. The two middle nuclei of the body then fuse with each other. A sixth pair is soon developed at the internal part of the circumference of the optic foramen: finally, a seventh appears between this and the fourth. Thus, towards the beginning of the seventh month, the sphenoid portion is composed of thirteen distinct nuclei, since although seven pairs of nuclei are formed, the first two germs of the body are already united.

After this period, the number of osseous nuclei continues to diminish as they unite. The nuclei which unite first are those of the parts of the sphenoid portion, which still continue for a long time to form so many separate pieces; thus the fourth, the fifth and the seventh pairs become one; the first and the second become the second and third; the third and the sixth, a fourth and fifth; whence it follows that at eight months, the sphenoid portion is composed of five pieces, the two large wings, the anterior wings, and the body. In a short time the anterior wings unite, and the bone is then formed of four pieces only, next the body and interior piece unite, so that in the full-grown fœtus the sphenoid portion comprises three pieces, because the large wings and the pterygoid processes are still separated from those of the centre. These three pieces unite during the first months after birth.

The body and the large wings are very rarely united before joining with the small wings, already blended with each other; then, the sphenoid portion is composed of two parts, an anterior, which is larger, and a posterior, which is smaller. This anomaly is certainly very remarkable, because it coincides perfectly with the arrangement existing in most mammalia during the whole period of existence.

The body of the sphenoid portion is full and solid for a long time after birth. The sphenoid sinuses are however gradually developed, 1st, because the bony substance disappears in the middle; 2d, because a special layer of bone, called the *sphenoidal horn*, forms on each side, and from below upward; this seldom remains distinct, but is generally fused with the sphenoid bone, rarely with the ethmoid or palate bone.

The sphenoid bone is thus gradually developed by sixteen, and the basilar bone by twenty-seven points of ossification*.

* See, on this subject, our *Considérations anatomiques et physiologiques sur les pièces osseuses qui enveloppent les parties centrales du système nerveux, et sur*

§ 545. The occipital portion of the basilar bone articulates backward and upward with the parietal bones, in most of its extent, which gives rise to the lambdoidal suture. At the place where the parietal bones cease, the articulation of the mastoid portion of the temporal bone with the lower extremity of the squamous portion and the posterior part of the condyloid portion of the occipital bone, commences; this produces the mastoid suture, at the end of which the jugular process joins the posterior part of the internal edge of the petrous portion of the temporal bone. We then find between this last and the condyloid portion a space for the sinus of the jugular vein. Finally, the external edge of the condyloid and of the basilar portion unites, by a fibro-cartilage, with the anterior part of the internal face of the petrous portion of the temporal bone.

The sphenoid portion articulates with the summit of the petrous portion of the temporal bone, by the posterior edge of the large wing by a broad layer of fibro-cartilage, and by the sphenoidal spine by means of a suture; with the anterior edge of the squamous portion of the temporal bone, by the internal edge of its large wing; with the frontal bone above, and with the malar bone below, by the anterior edge of this same wing. Between the lower edge of the anterior face of the large wing and the posterior edge of the upper face of the body of the superior maxillary bone, we find the *spheno-maxillary* or *inferior sphenoidal fissure* (*fissura spheno-maxillaris*, s. *sphenoidea inferior*), which is applied at an acute angle backward, inward and upward against the sphenoidal fissure. The upper edge of the anterior and internal face of the sphenoid portion, articulates with the posterior edge of the orbital portion of the frontal bone. Where the large wing separates below to form the inferior edge of the upper sphenoidal fissure, the suture is continuous between the small wing and the frontal bone.

Where the frontal bone terminates, the anterior edge of the body of the sphenoid portion articulates with the posterior edge of the cribriform plate. The posterior edge of the perpendicular plate of the ethmoid bone lies along the sphenoidal crest, and the beak of the sphenoid bone insinuates itself into the cleft of the vomer. Finally, the perpendicular portion of the palate bone descends, in front, on the inside of the internal plate of the pterygoid process, and its pyramidal portion insinuates itself into the pterygoid fissure.

In this manner the basilar bone articulates with all the bones of the skull, and with five of those of the face.

§ 546. The occipital portion of the basilar bone presents numerous and very various anomalies, while those of the sphenoid portion are rare, and of an entirely opposite character. The original defects of formation of the former consists essentially in its division into several pieces; this anomaly is most common in its squamous portion. The least anomaly is the existence of a greater or less number of small bones in the lambdoidal suture. We not unfrequently find one of them at the summit of this suture, where it results from a want of

leurs annexes, in the *Journal complémentaire du Dictionnaire des sciences médicales*, vol. i, p. 211). Spix has arrived at the same conclusion as ourselves, (*Cephalogenesis*, p. 17.)

union of the last pieces of which the squamous portion is composed with the others. It is less frequent that the third piece, on one or both sides, is not united, and forms a large bone, which descends obliquely in the lower part of the lambdoidal suture.

More rarely still the second pair remains separated from the first which is the lowest, by a suture passing obliquely through the middle of the squamous portion.

Finally, the rarest anomaly is where a longitudinal suture traverses all the height of the squamous portion from the angle of the lambdoidal suture to the large occipital hole, and divides it into two lateral portions.

So, too, the condyloid portions seldom remain a long time separate from the squamous and basilar portions: still less do they continue distinct during life.

The condyloid portions and the basilar process vary from the normal state, principally by the existence of unusual processes, which are directed from above downwards, and are often considerably long; these exist most generally near the occipital foramen, either on one or both sides, and are more or less firmly articulated with the transverse processes of the first cervical vertebra. These processes are much more rarely found before the occipital foramen, between the anterior extremities of the two condyles.*

II. OF THE TEMPORAL BONES.

§ 547. The *temporal bones* (*ossa temporum*)† are situated on the sides of the head, and are separated from each other below by the basilar bone, and above by the parietal bones. They occupy part of the middle region of the base of the skull, and the inferior part of its lateral faces. We distinguish in it a part which is more solid and thick, and which may be compared to the bodies of the vertebræ, and the lateral parts, or the arches, from whence processes arise. Each of these bones, however, only represents the half of a vertebra. The *rock*, or *petrous portion* (*pars petrosa*) is the body; and the *squamous portion* (*pars squamosa*), which reaches above the last, is the arch. Usually, this bone is divided into three parts—the *squamous*, the *petrous*, and the *mastoid* portion. The last, however, is only an appendage of the second.

§ 548. The most important part of the temporal bone is that which corresponds to the body of the vertebræ,—the petrous portion, and is so called from the hardness which characterizes it when perfectly developed. It is also called the *pyramid*, from its triangular form. Its base is turned outward and backward, its summit forward and inward. One of its three faces looks forward and upward, a second backward and inward, and a third downward. The first and the second are separated

* Meckel, *De monstr. duplic.* p. 21.—*Deutsches Archiv. für die Physiologie*, vol. i. part iv. p. 6.

† We shall not mention here the internal structure of the temporal bone, nor the little bones of the internal ear. These will be described when speaking of the organ of hearing.

from each other by the upper, the second and the third by the inner, the third and the first by the outer angle.

§ 549. The internal organ of hearing is situated within the petrous portion. The internal carotid artery passes through it to penetrate the skull, and the facial nerve to go to the face. On its surfaces and edges we can trace these two passages. We see also others which correspond to the anastomoses of the nerves, and to the venous sinuses of the dura-mater.

§ 550. The most important of these marks relate to the organ of hearing.

Near the centre of the upper face, we find a large transverse ridge, formed by the projection of the upper semicircular canal of the labyrinth, which is here naked during the early stages of uterine existence, at which period it is not yet covered with a plate of bony substance; and we remark above it a deep fossa, which receives the dura-mater, the traces of which are gradually effaced after birth.

In the middle and forward, we see on the internal face a considerable rounded opening, depressed from above downward, in which the auditory and the facial nerves are situated. This is the *internal auditory foramen* (*porus acusticus internus*). This opening leads into a cavity, divided by a transverse portion into two openings; a superior, which is smaller, and an inferior, which is larger; the former leads into the *Fallopian canal* (*aqueductus Fallopii*) by several openings, the other to the *labyrinth.*

Below this opening, on the boundary between the inner and the lower face, we find the *triangular orifice of the aqueduct of the cochlea;* behind which we see, at the same height, *the orifice of the aqueduct of the vestibule,* which is turned back and flattened.

On the limit between the upper and the lower face, are two imperfect bony canals, separated from each other by a bony projection. The inferior, which is also larger, is the *osseous portion of the Eustachian tube* (*tuba Eustachiana ossea*). The upper is smaller, and gives attachment to the tensor muscle of the membrane of the tympanum (*musculus tensor tympani*).

The external portion of the inferior face, which is the most extensive, forms an elliptical canal, *the osseous portion of the auditory passage* (*meatus auditorius osseus*), which opens externally by a broad orifice, called the *external auditory foramen* (*foramen* s. *porus acusticus externus*).

The Fallopian canal proceeds first obliquely from above downward, and from within outward; then from behind forward, and from below upward, to arrive at the inferior face, where it terminates in the *stylo-mastiod foramen* (*foramen stylo-mastoideum*). It gives passage to the facial nerve.

On the upper surface, along and over the canal for the tensor tympani muscle, is a fissure leading to a canal which opens with the aqueduct of Fallopius.

At the anterior extremity of this surface, above and within the anterior orifice of the carotid canal, we observe a semicircular and superficial depression, which corresponds to the nerve of the fifth pair.

§ 551. The traces of the vessels are, 1st, the *the canal of the internal carotid artery* (*canalis caroticus internus*), which curves from below upward and from within forward, of which the *external orifice* (*foramen caroticum externum inferius*) is found in the centre of the inferior face, while the *internal* (*foramen caroticum anterius* s. *superius*) is seen at the summit of the superior face, where this canal, deprived of its upper wall in a considerable extent, forms in reality only a semi-canal.

2d. On the inferior surface, directly behind the orifice of the aqueduct of the cochlea and the posterior opening of the carotid canal, is a more or less extensive *fossa* (*fossa bulbi venæ jugularis internæ*) for the sinus of the internal jugular vein ; a fossa which communicates by fissures with the two aqueducts.

3d. At the upper angle the *fissure of the superior petrous sinus* (*sulcus petrosus superficialis*).

4th. On the internal surface of the mastoid process, the *fissure of the transverse sinus* (*sulcus sinus transversi*), which is generally directed very far forward and upward, and occupies most of this surface. Very rarely, this fissure is very small, or is even entirely deficient, when the transverse sinus, varying from its usual rout, descends entirely or almost entirely on the occipital bone alone, or follows a longitudinal direction. Of more than fifty well developed temporal bones before us, the fissure is entirely deficient in but one, and extremely small in two only.

5th. We generally see on its posterior face, a little above the centre, the *mastoid hole* (*foramen mastoideum*), the internal orifice of a canal which usually extends some lines within the bone, and commences on the boundary between the mastoid portion and the occipital bone, or on the outer face of the mastoid portion.

§ 552. The muscular eminences and depressions are—

1st. The *styloid process* (*processus styloideus*), at the posterior extremity of the under edge of the pyramid : this varies much in length, and sometimes exceeds two inches. This process is sometimes entirely free, and is often composed of several pieces—a curious analogy with animals. It arises between two broad, flat, bony processes, called the *vaginal processes* (*vaginæ processus styloidei*).

2d. Behind the styloid process is the conical *mastoid process* (*processus mastoideus*). The *stylo-mastoid foramen* (§ 550) (*foramen stylo-mastoideum*) is situated between these two eminences.

3d. Behind the mastoid process is the *mastoid fissure* (*incisura stylo-mastoidea*).

§ 553. The *squamous portion* is slightly rough on its outer face for the insertion of the temporal muscle. Forward and downward the external face extends in a thin process, flattened from without inward, called the *zygomatic process* (*processus zygomaticus jugalis*), and of which the external and longer root is placed over the external auditory foramen, the orifice of which it closes above, while the lower, which is

transverse, and called the *articular eminence* (*tuber articulare*), is found before the *transverse articular cavity* (*cavitas articularis*) of the lower maxillary bone. Anteriorly, it circumscribes this cavity, with which it is insensibly continuous. Behind, the cavity is bounded by a transverse projection, situated before the anterior part of the osseous auditory passage, but entirely separate from it, and which varies much in thickness and height.

Advancing from behind forward, the zygomatic process separates a little from the squamous portion, and its anterior extremity reaches over the anterior edge of the same.

The internal surface of this portion of the temporal bone presents digital impressions and mamillary eminences, and generally, at its upper part, a transverse arterial fissure.

§ 554. In the full-grown fœtus, the temporal bone is formed of four pieces of bone, the *petrous*, the *mastoid*, and the *squamous* portions, and the *ring of the tympanum* (*annulus membranæ tympani*). This last is the only vestige of the osseous auditory canal. It is elliptical in form, longer from above downward than from before backward, is not entirely closed at its upper part, is attached to the petrous portion immediately before the cavity of the tympanum by almost its whole external circumference, and to the lower part of the squamous portion by its two upper extremities, is broader and thicker before than behind, and offers, at its internal circumference, a deep fissure, in which the membrane of the tympanum is inserted.

Some time after birth, these four parts are fused together. The separation, which existed between the upper extremities of the ring of the tympanum and the squamous portion disappears first. The trace of separation which continues the longest is between the petrous and the squamous portions, especially on the internal face: for, although the marks of separation between the squamous and the mastoid portions disappear entirely on the outside, we see through life a suture which exists in most of its length, between the internal face of the squamous, and the upper face of the petrous portion. This suture, called the *squamo-pyramidal suture* (*sutura squamoso-pyramidalis*), extends forward, where it is called the *fissure* of *Glaser* (*fissura Glaseri*), passes under the articular cavity, before the bony portion of the auditory canal, through all the substance of the bone, and terminates in the cavity of the tympanum.

The ring of the tympanum gradually enlarges, and unites with the petrous portion on all sides, and increasing out of proportion with the other parts of the bone, from a simple ring rounded and flattened from without inward as at first, it becomes a canal half an inch long and compressed from before backward, *the osseous portion of the auditory canal*, which remains however for a long time imperfect and cartilaginous at the lower part of its circumference, backward.

However, the petrous and squamous portions increase also very much, by the development of the mastoid process. At the same time, the squamous portion is not only higher, but becomes more convex ex-

ternally, instead of being straight as hitherto. The zygomatic process also changes its form; it throws itself outward, separates very much from the squamous portion, and extends beyond its anterior edge in the same proportion. A remarkable change supervenes also in the situation of the glenoid cavity and of the articular process, which previously plain, very broad from before backward, and very oblique from above downward, and from without inward, become almost transverse, and are considerably developed, which gives more firmness to the temporo-maxillary articulation.

§ 555. The temporal bone articulates, 1st, by its mastoid, petrous, and squamous portions, with the basilar bone behind and forward. 2d. By its mastoid and squamous portions above with the inferior edge of the parietal bones. The first articulation is by a serrated suture, and the second by the squamous suture (*S. squamosa*) the two bones gradually becoming thin to the extent of from four to six lines, and fitting to one another, so that the squamous portion covers the parietal bones. 3d. The temporal bone articulates with the malar bone by a dentated suture, and 4th, with the lower maxillary bone, which moves upon it, by ligaments.

III. OF THE PARIETAL BONES.

§ 556. The *parietal bones* (*ossa bregmatis*, s. *verticis*, s. *parietalia*), are only portions of a vertebra. We ought to consider them as the complements of the lateral parts of the temporal bones and of the sphenoid bone, between which they are wedged in. They stand together on the median line, and are often united in a single bone. They occupy the upper part of the lateral faces and the summit of the skull, have an almost regular quadrilateral form, and are flat in every part.

§ 557. The edges which circumscribe them are the *upper*, *inner*, or *sagittal edge* (*margo sagittalis*), the *anterior*, *fronta*, or *coronal edge* (*margo frontalis*, s. *coronalis*), the *inferior* or *squamous edge* (*margo squamosus*), and the *posterior* or *occipital edge* (*margo occipitalis*). The angles formed by the union of these four edges are called, the *upper* and *anterior* or the *frontal angle* (*angulus frontalis*), the *upper*, *posterior* or the *occipital angle* (*angulus occipitalis*), the *lower* and *anterior* or the *spheniod angle* (*angulus sphenoideus*), and the *lower* and *posterior* or the *mastoid angle* (*angulus mastoideus*).

§ 558. They appear especially on their outer face, and more particularly, in young subjects, formed very distinctly of two portions, united at an obtuse angle, the upper, which is larger, and the inferior, which is smaller. The skull is broadest where these two portions join; this part is called the *parietal protuberance* (*tuber parietale*). The upper is smooth, the lower is slightly uneven, and separated from the other by an arched rim, whence it has been called the *semi-circular surface* (*planum semi-circulare*).

The internal face, besides the usual cerebral and digital impressions, presents ascending and branching channels, which lodge arteries and

veins (*sulci meningei*), called, from their arrangement, the *fig-leaf*. We also remark, especially in old subjects, along the upper and internal edge *slight depressions* (*foveæ glandulares*), which sometimes extend even to the external table. At the inferior and posterior angle, a transverse furrow (*sulcus transversus*), constantly exists and completes that seen on the occipital and temporal bones (§ 551); along the sagittal edge is a slight fossa, which united to that on the opposite side, forms the *fossa of the upper longitudinal sinus* (*sulcus sinus longitudinalis*).

Near the sagittal edge, we usually perceive on one or both of the parietal bones, the *parietal foramen* (*foramen parietale*).

§ 559. Each parietal bone developes itself by a single point of ossification, which first appears in the parietal protuberance.

§ 560. These bones articulate with each other upward and inward, along their upper edge by the *sagittal suture* (*sutura sagittalis*), which goes directly from before backward on the median line; backward, with the occipital bone (§ 555); downward, with the temporal bone, by most of their squamous edge, and with the large wing of the sphenoid bone (§ 555) by the rest of this edge, as also by the sphenoid angle; finally, with the frontal bone, by their anterior edge and by the *coronal suture* (*sutura coronalis*).

§ 561. The sagittal suture is sometimes wholly or partially effaced, and the two parietal bones become one, although all the other bones remain separate and distinct.

On the other hand, we sometimes, but much more rarely, see one or both of them divided by a transverse suture into an upper and a lower portion. We do not know that they are ever divided by a longitudinal suture into an anterior and a posterior portion.

IV. OF THE FRONTAL BONE.

§ 562. The *frontal* or the *coronal* bone (*os frontis*) occupies the anterior part of the skull. It corresponds to the squamous and condyloid portions of the occipital bone. We observe, also, in the place corresponding to the large occipital foramen, an analogous opening, which however is not closed behind, because the frontal bone has no basilar process. Perhaps this last is represented by the body of the sphenoid bone.

§ 563. This bone is divided into a *frontal portion* (*P. frontalis*), an *orbitar portion* (*P. orbitalis*), and a *nasal portion.* (*P. nasalis*).

§ 564. The *frontal portion* is by far the largest. It corresponds to the squamous portion of the occipital bone in form and situation. Like that, it is composed of two parts, united at an obtuse angle, the upper being more extended than the lower. Where both of these join is the part where the bone projects the most, and presents on each side the *frontal tubercle* (*tuber frontale*). Below these eminences, we find on each side also, directly above the upper edge of the orbit, and inward, another protuberance separated from it by a depression, called the *superciliary ridge* (*tuber superciliare, supra-orbitale*), where the two

tables of the bone are separated from each other to form the *frontal sinuses* (*sinus frontales*). The triangular space on the median line, which separates the two ridges, is called the *glabella*. But a small extent of the region of the anterior face, that which looks a little outward, and completes the semicircular surface of the parietal bone (§ 558), is rough.

The inner face is divided into two lateral parts by the *frontal crest* (*crista frontalis*). This, which is found on the median line, forms sometimes a very considerable projection, and terminates upward by a furrow, the commencement of the *longitudinal fossa* (*sulcus longitudinalis.*) These two portions are uneven, like those of the internal face of the parietal bones.

§ 565. The *orbitar portion*, which unites with the preceding at a right angle, is separated from it externally by a projecting and round edge called the *orbitar arch* (*margo superciliaris*, s. *supra-orbitalis*). At the internal extremity of this edge passes the *frontal fossa* or *canal* (*sulcus* s. *canalis frontalis*), extending from the under face of the orbitar portion to the external face of the frontal portion. This edge enlarges outwardly, as does also the inferior part of the anterior face of the frontal bone, to produce the short but strong *malar protuberance* (*tuber jugale*).

The orbitar portion, which forms the arch of the orbit, is contracted from before backward, convex upward on the side of the skull, concave downward on the side of the orbit, and very thin. At the internal part the two tables separate from each other (§ 564).

The inferior face presents, outward and forward, the *lachrymal fossa*, which is usually superficial ; inward and forward, a small eminence or depression, called the *trochlear spine* or *fossa* (*spina* s. *fovea trochlearia*).

§ 566. Between the frontal and orbitar portion is the *nasal* part, which is properly only the most internal part of the two others, and is in the form of a horse-shoe. It is composed of two portions, which unite anteriorly in an arch below the middle of the frontal portion, and the tables of which, very widely separated, especially in front, contain the access to the frontal sinuses, and are separated by the *ethmoidal fissure* (*incisura ethmoidalis*). The *nasal spine* (*spina nasalis*), which often forms a separate piece of bone, arises from their place of union. Between this spine and the inferior extremity of the frontal crest, we observe a considerable opening, improperly called the *foramen cæcum*.

§ 567. The frontal bone is developed at the second month in two lateral pieces, separated longitudinally on the median line, the union of which generally begins during the first year, and is finished toward the end of the second. These two pieces by their mutual articulation produce the *frontal suture* (*sutura frontalis*), which has the same direction as the sagittal suture, and whose lower part is always effaced the last.

§ 568. The frontal portion of the frontal bone articulates above, 1st, with the parietal bones, by the *coronal suture* (*sutura coronalis*)

(§ 560) ; 2nd, the orbitar portion articulates downward and backward with the small and large wings, as well as with the body of the sphenoid bone (§ 545), by the malar process ; 3rd, with the malar bones (§ 595), by the lateral parts of the nasal portion ; 4th, with the ethmoid bone (§ 574), by the anterior part of this portion and by the nasal spine ; 5th, with the proper bones of the nose; and 6th, on the outside of these with the upper maxillary bones.

§ 569. The most usual anomaly presented by the frontal bone, and which is not rare, consists in the want of union of its lateral portions. The frontal suture then remains during life. More rarely the frontal sinuses are not developed.

V. OF THE ETHMOID BONE.

§ 570. The *ethmoid* or *cribriform* bone, (*os ethmoideum* s. *cribriforme*) is found at the anterior and middle part of the base of the skull. It slightly resembles a vertebra in its thin and perpendicular middle layer, and in its two lateral portions, which are folded on each other in different ways. We might rather consider it a bone of the face, and more so because it is wedged in between these bones, among which are numbered some not more perceptible externally than this, and resembling it in form and functions.

§ 571. We distinguish in the ethmoid bone a central and two lateral portions. The first is formed almost wholly by a *perpendicular plate* (*lamina perpendicularis*) much higher in its anterior than in its posterior portion. Behind, where the posterior portion terminates, we see detached from its upper edge a horizontal layer, called the *cribriform plate* (*lamina cribrosa*), which extends on both sides. This plate is placed along the perpendicular plate, the upper part of the anterior portion of which consequently rises much above it. This latter, called the *crista galli process*, projects within the cranium; it is much thicker than the part below.

The *cribriform plate* presents two series of oblong openings, the largest of which are situated inward, along the *crista galli* process, and in the same direction from before backward, while the smallest are found along its external edge. The anterior and middle are the largest, and are oblong, often three or four lines in extent. Between these two ranges are others, which are smaller and irregular.

All these are the tunnel-shaped orifices of small canals ; the internal pass several lines along the lateral faces of the perpendicular plate, and then divide into others which are smaller, and degenerate into simple fissures, which descend very low in the septum.

§ 572. The *lateral portions* of the ethmoid bone, or the *labyrinths* (*labyrinthi*), are extremely thin and complicated. Each generally represents a quadrangular cavity, which is longest from before backward, and shortest from within outward. The upper wall is generally partially or wholly deficient, and is covered by the sides of the nasal part of the frontal bone, which serve as a top to it; the anterior wall is also open. The outer side is sometimes, but more rarely, imperfect : it is smooth and straight, and is called the *os planum*, or *lamina*

papyracea, because it has the smoothness of parchment. The inferior wall is very uneven ; the posterior is deficient, the internal is straight, and rendered uneven by the external range of openings found on the cribriform plate, as also by the descending canals and fissures which penetrate its substance by small openings. Posteriorly, this internal wall forms two projections placed one over the other, separated by a deep space, convex within and concave externally, called the upper and middle turbinated bones (*concha superior et media*). The latter turns on itself anteriorly, hence it is convex externally. The lower turbinated bone forms the inferior wall of the labyrinth.

Transverse, irregular, and partly imperfect plates proceed from the outer to the inner part of the labyrinth, forming a greater or less number of *ethmoidal cellules* (*cellulæ ethmoidales*). The anterior cells are also called the *orbital* or *lachrymal*, (*C. orbitariæ* s. *lachrymales*), the middle, the *frontal* (*C. frontales*), and the posterior, the *palatine* (*C. palatinæ*)

From the upper edge of the middle turbinated bone a transverse septum proceeds to the posterior edge of the os planum, and closes, but imperfectly, the middle cellules.

This septum and the os planum are extended backward and downward at their anterior and inferior angle into a thin, sometimes a slightly curved process, called the *small ethmoidal process* (*processus minor*). Another arises farther forward and inward, from the anterior part of the labyrinth and the transverse septa of the anterior cellules, between the anterior extremity of the middle turbinated bone and the os planum. This varies much in length, and is called the *large* or *unciform process of the ethmoid bone* (*processus major*, s. *unciformis*, s. *hamulus*).

§ 573. The ethmoid bone is not developed till the fifth month. The lateral portions appear first, and the middle part is not formed till after birth.

In the full-grown fœtus, this middle part is entirely cartilaginous : the two lateral portions are separated from each other, and but slightly developed, for the external and internal walls almost touch. However, the eminences we have mentioned, already exist, although, even relatively speaking, much smaller. The cribriform plate is very broad, and broader in young children than in adults : it contracts when the internal and external walls of the labyrinth are separated from each other. Even long after these three parts are fused together, the middle, which ossifies from above downward, continues to be almost cartilaginous. Its inferior and anterior part, which belongs to the cartilaginous septum of the nose, always retains this character.

§ 574. The ethmoid bone is articulated ; 1st, forward and upward, by the anterior edge of its perpendicular plate, with the middle nasal portion of the frontal bone and the posterior edge of its nasal spine ; 2nd, upward, on each side, by the upper wall of the labyrinth, with the nasal and orbitar portions of the frontal bone; 3rd, before, and on the side with the unguiform bone : 4th, by the posterior edge of its

cribriform plate, and by its perpendicular plate, with the middle edge of the upper face of the body of the sphenoid bone and with the sphenoidal spine ; 5th. by the posterior part of the labyrinth, with the palate bone; 6th, by the inferior edge of the os planum, with the body of the superior maxillary bone in the orbit, and by the anterior part of the labyrinth, with the ascending process of the same bone in the nasal cavity; 7th, by the inferior edge of the septum, with the vomer ; 8th, by the anterior part of the labyrinth, with the nasal bone ; 9th, finally, sometimes by its large process with the inferior turbinated bone.

§ 575. The os planum sometimes divides into several distinct laminæ, which are generally situated one behind another.

CHAPTER II.

OF THE BONES OF THE FACE.

§ 576. The *face* is composed of fourteen bones. We may, however, oppose the region of the upper jaw to that of the lower jaw ; for, 1st. The different bones which form the first, are united by the suture which admit of no motion, while the lower maxillary bone is articulated so as to play freely. 2nd. Most of the bones of the upper maxillary region may be considered as the appendages of one large piece, the upper maxillary bone. 3rd. The lower maxillary bone is not, in many animals, a single bone as in man, but is composed of several, and often of a great number of bones.

§ 577. Most of the bones of the region of the upper maxillary bone, are in pairs. Of these, there are six, viz. 1st, two *upper maxillary* bones ; 2nd, two *palate* bones ; 3rd, two *malar* bones ; 4th, two *nasal* bones ; 5th, two *lachrymal* bones , 6th, *turbinated* bones ; 7th, the *vomer* is a single bone. Both Lietaud and Portal have remarked, after the ancient anatomists, that the vomer usually unites early with the ethmoid bone, so that connecting these together, we have then only six pairs to describe with the superior maxillary bone. The region of the lower maxillary bone is composed of a single bone. In the face, as in the skull, the unmated bones are situated on the median line, or are composed of two lateral corresponding portions.

§ 578. All these bones are not developed by a single point of ossification, but their different osseous nuclei unite, the lateral portions of the lower maxillary bone excepted, long before those of the skull, and generally before those of most bones; perhaps, because they are smaller, and not like the pieces of the skull and vertebral column, because immediately connected with an organ, in which the formative power exerts all its energy.

I. OF THE UPPER MAXILLARY BONES.

§ 579. The *upper maxillary bones* (*ossa maxillaria*, s. *mandibularia superiora*, s. *maxillæ superioris*) principally determine the form of the

whole face, because they are the largest, and are situated in the centre of the others.

Their form is almost quadrilateral. We usually distinguish a body and four processes, inclining upward, outward, downward, and inward.

The upper face of the body is smooth; its direction is obliquely downward, outward, and a little forward. We generally observe from before backward, a semi-canal, open at its upper part, and extending from the posterior edge to about its centre; this is continuous, after leaving this point, with a perfect canal called the *infra-orbital canal* (*sulcus* s. *canalis infra-orbitalis*) which passes below it, to open on its anterior face. The track of this canal is generally indicated also at the upper face of the body of the upper maxillary bone by a very narrow fissure, which does not, however, always extend there, although it did originally. More rarely, this duct forms in its whole length a perfect canal; and then, sometimes the fissure exists in its whole extent, and sometimes it is entirely deficient, but only in the place where it is found in the normal formation. Sometimes also, this fissure is occasionally interrupted, independent of the arrangement of the posterior part of the duct. Finally, it often happens that the semi-canal is extended very far, almost even to the anterior edge of the upper face. These differences are worthy of remark, as they indicate the different degrees in the development of the bone.

§ 580. On the upper face, we generally see upward and inward, the extremity of the fissure described, which leads to the *infra-orbital foramen*. This hole is rounded, terminates sharply above; while, below, it is prolonged into a more or less deep depression, and is not far from the anterior edge of the upper face. Sometimes, but rarely, instead of one foramen, there are several: we then find, at a greater or less distance from the usual large foramen, another opening, which is smaller and situated more inwardly; in which case, the canal is divided sooner or later into two branches. In certain cases, the two holes are more than half an inch apart, and the canal is divided at its posterior extremity; differences which are remarkable as establishing an analogy with the formation of the simiæ and cetaceæ.

Below the infra-orbital foramen, we find a deep muscular impression, the *maxillary fossa* (*fossa maxillaris*).

The posterior part is convex, and presents below the *maxillary protuberance* (*tuber maxillare*).

The inner part is very uneven. We remark anteriorly and about its centre, the *inferior turbinated spine* (*spina turbinalis inferior*), an eminence almost straight, which, however, descends a little obliquely forward and is very rough. We then see the *lachrymal groove* (*sulcus lachrymalis*), which goes downward and backward from the upper edge, and is sometimes changed into a canal in a small part of its extent, when its anterior and posterior edges touch. Further still, at the upper part of this face, a large hollow occupies a part of it, which extends almost to the posterior edge, and leads into the antrum Highmorianum.

The body is hollow, and its walls, especially the upper, are very thin. The *maxillary sinus*, or the *antrum Highmorianum* (*antrum maxillare*, s. *Highmori*), which is within it, and opens into the nasal cavity by its internal wall, is often curved with eminences which render its surface uneven.

§ 581. The *ascending*, *upper* or *nasal process* (*processus ascendens*, s. *superior* s. *nasalis*), leaves the anterior and internal angle of the upper face of the body, and is flattened from within outward. The posterior and smaller part of its external face is separated from the anterior by an eminence sharper below than above, and is continuous with the upper anterior edge of the body. This part is hollowed out, and forms the beginning of the *lachrymal groove*. Its internal face is a little concave, and we see on it, near the middle, the *ethmoidal spine* (*spina ethmoidalis*), parallel to the inferior turbinated spine; sometimes when the nasal process is very broad, it is divided by a sharp crest into an anterior and a posterior portion, the latter of which is much more hollowed, and assists in forming the anterior cellules of the ethmoid bone.

§ 582. The *palatine process* (*processus palatinus*) detaches itself from most of the inferior edge of the internal face, at a right angle, and goes horizontally inward. Its upper face is smooth, and the under is rough. It terminates backward by a serrated edge, inward by an uneven and broad surface, especially at its anterior part. It is continuous forward with the alveolar process. In this place it is traversed from above downward, and from behind forward, by the *palatine* or *incisory channel* (*canalis palatinus* s. *incisivor*), which usually forms only a simple semi-canal, because its internal wall is deficient, as is the entire length of the external wall, from which a fissure usually proceeds forward and outward, and, in this manner becomes apparent both at the upper and the lower face of the palatine process. Here, particularly, the fissure is longest and broadest, and goes towards the space situated between the outer incisor and the canine tooth. It rarely bifurcates at its inferior face, presenting an inner which is smaller, between the two incisor teeth. Sometimes, also, a small process is detached which goes backward. The fissure, visible at the inferior face, is the *intermaxillary suture* (*sutura intermaxillaris*).

One or more furrows proceed from the posterior edge from behind forward, to the inferior face.

§ 583. The *alveolar process* (*processus alveolaris*), is a prolongation of the anterior and external face of the body; it is convex outward and concave inward, forming a considerable edge, and contains cavities for the teeth called the *alveolar* cavities (*alveoli*), which are separated by thin osseous partitions. The alveoli are known externally by the projections, and the intermediate partitions, by the depressions which correspond to them.

§ 584. The *malar* or *jugal process* (*processus malaris* s. *jugalis*) is very short. It comprises only the broad rough surface, by which the posterior, superior, and anterior faces of the body are united. A portion

of the bony partition of the maxillary sinus is often deficient in this region.

§ 585. The upper maxillary bones articulate, 1st, on the median line, with each other, by the internal face of the palatine portion; 2d, with the frontal bone (§ 568), by the upper extremity of the nasal process; 3d, with the external edge of the proper nasal bones, by their anterior edge; 4th, with the unguiform bones, by their posterior edge and the anterior extremity of the internal edge of the upper face of their body; 5th, with the ethmoid bone (§ 574), by this same edge, and by the crest of the ethmoid bone; 6th, with the palate bones, by the posterior extremity of this edge, the posterior part of the posterior and internal face of the body, and the posterior edge of the palatine portion; 7th, with the inferior turbinated bone, by the inferior turbinated spine; 8th, with the vomer, by the palatine process.

§ 586. According to Portal, the upper maxillary bone is developed by several points of ossification,—two for the body, one below the infra-orbital foramen, and another in the floor of the orbit; a third in the nasal process, and two or three in the palatine process.

In several fœtuses of three months, we have found it composed of three pieces; of these, the anterior comprises the portion of the palatine and alveolar processes situated before the palatine duct, with the nasal process; the middle, the body and the central part of the palatine process; finally, the third placed externally, the posterior part of this same process. The palatine canal, which is still only a simple hole, the *incisive* or *anterior palatine foramen* (*foramen incisivum* s. *palatanium anterius*), appears enormous. The inner, the upper, and the posterior walls of the body are not yet formed. Then, *the anterior portion is separated from the posterior*, and *a real intermaxillary bone exists*,—a curious analogy with what is normally observed in almost all the animals inferior to man. Even when the two segments are not more entirely distinct, in the full grown fœtus and afterwards, the line of separation extends much farther, both in breadth and in length, across the palatine portion, so that it traverses all the breadth of the upper face. It often happens that it does not stop there, but is reflected upward, and insulates a part from the internal face of the body as an internal thin layer, which is only applied against the external part. Farther, a branch of this upper fissure goes inward, and passes behind the lachrymal channel, through the antrum Highmorianum, to the posterior face of the body, where it unites with the infra-orbital *fissure* in the infra-orbital canal. We also find some slight traces of this arrangement in the adult; it deserves to be remarked, as indicating, even in man, that the portion of the upper maxillary bone, in which the incisor teeth are situated, is separated from the others during the early periods of life, and then forms a real *intermaxillary bone* (*os incisivum intermaxillare*). We always find in the young fœtus the internal branch of the fissure on the under face of the palatine portion (§ 582), and this observation, together with the instances of division of the upper

maxillary bone in the full grown fœtus,* seems to prove the primitive existence of a special piece of bone for each incisor tooth.

The maxillary sinus is already very large in the full grown fœtus, but does not extend so much outwardly.

Considered generally, the maxillary bone in the child, particularly its alveolar portion, is much longer and broader in proportion to its height, than in the adult.

§ 587. The anomalies of this bone are, the non-development of the maxillary sinus, and the shortness of its palatine process, which leaves a greater or less interval on the median line between the maxillary bones, and whence generally results (at least when the division extends to the anterior extremity, or occupies the anterior part of the length of the upper jaws) the insulation of the anterior portion which supports the incisores, or of the intermaxillary bone. On the other hand, it sometimes happens also that the palatine process is prolonged posteriorly to a great extent, and even forms the posterior spine.

II. OF THE PALATE BONES.

§ 588. The *palate bones* (*ossa palati*) should be regarded as the posterior appendages of the upper maxillary bone. They correspond from behind forward, to the intermaxillary portion of the upper jaw.

They are thin layers curved on themselves, the upper larger and perpendicular part of which corresponds to the inner wall of the body of the upper maxillary bone, and the horizontal to the palatine process of this same bone, of which they are the continuation and the termination.

§ 589. The internal face of the horizontal portion presents two parallel eminences, separated very much from one another, which extend from the posterior to the anterior edge, and are called the *upper and lower turbinated crests*, or the *transverse eminences* (*crista turbinalis superior et inferior*, s. *lineæ eminentes transversæ*). The external face is concave in the points corresponding to these two eminences, smooth in its anterior portion which is the most extensive, and hollowed posteriorly, by one or two longitudinal furrows, called the *pterygo-palatine fossæ* (*sulci pterygo-palatini*), which are continuous with the furrow of the palatine face of the upper maxillary bone.

The rough posterior edge presents downward, backward and outward where the perpendicular part unites to the horizontal portion, a thick eminence called the *pyramidal* or *pterygoid process* (*processus pyramidalis* s. *pterygoideus*). The anterior edge is thin, uneven, and extends below the inferior transverse line, in a small projection called the *nasal process* (*processus nasalis*). Above, the perpendicular portion divides into two eminences, the anterior called the *orbital process* (*processus orbitalis*), and the posterior the *sphenoidal process* (*processus sphenoidalis*).

* Meckel, *Path. Anat.* vol. i.

The first is deeply concave inward, convex upward, backward and outward, straight forward, downward and outward, rough externally, and smooth in all other parts of its surface.

The sphenoidal process is lower than the orbital, a continuation of the posterior edge of the palate bone upward: it is directed toward the posterior part of the orbital process, but rarely meets it.

The space which remains between these two processes, and which is always filled by the dura-mater in the recent state, constitutes the *spheno-palatine foramen* (*foramen spheno-palatinum*).

The horizontal portion is terminated forward by a sharp, rough and thin edge; inward by a broad and uneven edge; backward by a smooth edge. The last is notched, and terminates internally by a pointed eminence.

§ 590. The palate bones articulate, 1st, with each other by their horizontal portions. The union of the internal eminences of their posterior edges gives origin to the *nasal* or the *posterior palatine spine* (*spina palatina posterior*); 2d, with the upper maxillary bones (§ 585); the anterior part of their perpendicular portion contracts the orifice of the antrum Highmorianum; the anterior part of the external face of this portion applies itself to that of the thin wall of the maxillary sinus found behind its orifice; the posterior remains a little distance from it, producing the *pterygo-palatine canal* (*canalis pterygo-palatinus*) between it and the edge of the posterior face of the maxillary bone; 3d, with the ethmoid bone, by the orbital process, so that the internal and concave face of this process covers and enlarges the posterior ethmoid cells, and the posterior extremity of the middle turbinated bone meets the upper process of its internal face; 4th, with the sphenoid bone; for the posterior edge of the perpendicular portion embraces the anterior face of the pterygoid processes, the pyramidal process insinuates itself between the two wings of these last, and the posterior face of the orbital processes applies itself to the anterior of the body; the horns of the sphenoid bone frequently make part of the palate bones, and are only an enlargement of the posterior face of the palatine process; the bone, wedged in between the pterygoid process of the sphenoid bone and the body of the superior maxillary bone, forms or completes with it the *pterygo-palatine fossa* (*F. pterygo-palatina*); 5th, with the posterior extremity of the lower turbinated bone, by the lower transverse eminence; 6th, finally, with the posterior extremity of the lower edge of the vomer, by the palatine crest.

§ 591. At first, the palate bone is situated very low, so that its perpendicular portion is shorter than its horizontal portion, and considerably large, particularly from before backward, in proportion to its other dimensions. We have found it in the fœtus of three months, composed of a single nucleus of bone, which appeared as a curved plate.

§ 592. The anomalies it offers consist in the separation of the two palatine portions, existing either alone or attended with a similar division of the upper maxillary bones. This anomaly seems to be

sometimes although rarely occasioned, and sometimes compensated for, by the extension of the palatine process of the maxillary bones backward, which is extremely remarkable.

III. OF THE MALAR BONES.

§ 593. The *malar* or the *cheek bones* (*ossa jugalia, zygomatica, malaria, malæ*) have an irregular quadrilateral form; they are convex externally and concave internally. They are composed of two pieces united at a right angle, the upper, smaller and internal; the lower, larger, perpendicular and external. The first is very much grooved upward and forward, and forms the anterior part of the anterior wall of the orbit. The second is situated outwardly under the skin of the cheeks, and forms, by its projection, the broadest region of the face.

§ 594. The *zygomatic canal* (*canalis zygomaticus*) which is generally single, sometimes double, or even multiple, passes through the malar bone. This canal commences by an upper orifice at the anterior face of the superior portion, and terminates, on one side, at the external face of the perpendicular portion, by the *external zygomatic foramen* (*foramen zygomaticum externum*); on the other, at the internal face of this same part, by another opening, called the *internal zygomatic foramen* (*foramen zygomaticum internum*).

§ 595. This bone articulates, 1st, with the malar process of the upper maxillary bone, by the anterior edge of its external portion, also by the internal edge of its superior portion, between which is a rough surface; 2d, by the posterior part of the inner rough edge of its horizontal face, with the edge formed outward by the union of the anterior and external faces of the large wing of the sphenoid bone; 3d, by its upper portion with the malar process of the frontal bone; 4th, by its inferior and posterior parts with the zygomatic process of the temporal bone. We call those prolongations by which this bone articulates with the sphenoid bone, the upper maxillary bone, and the temporal bone, the sphenoidal, the maxillary, and the temporal processes.

The greater part of its posterior edge is free.

The articulation of this bone with the temporal bone forms a *bridge* (*zygoma, jugum*) above the temporal fossa (*fossa temporalis*) comprised beetween the anterior part of the squamous portion, the large wing of the sphenoid bone and the posterior face of the malar bone; this bridge varies in form, according to the races.

§ 596. The malar bone appears early, toward the commencement of the third month. We have always found it composed of a single nucleus of bone. The numerous observations and facts on this subject carefully collected, would lead us to doubt the assertion of Portal, that there are three points of ossification.

§ 597. This bone is sometimes entirely deficient;* a striking resemblance with what is seen in several mammalia, as the taurec, the

* Meckel, *Beytrage*, vol. i. p. ii, p. 54.—Dumeril, *Bull. de la soc. phil.* vol. iii, p. 122.

sloth, and the ant-eater. It is sometimes divided by a suture into two portions, an anterior and a posterior,* or even into three pieces.†

IV. OF THE NASAL BONES.

§ 598. The *nasal bones* (*ossa nasi*, *nasalia*, *nasi propria*) are small bones, of an oblong square form, thick at their upper part, thinner and broader downward, which form the upper and anterior walls of the bony frame of the nose. They are situated obliquely from above downward and from behind forward, between the frontal bone, the maxillary bone, and the perpendicular plate of the ethmoid bone. They describe a double curve, whence they are concave forward and convex backward in their upper part, while in their lower part they are convex forward and concave backward. Near their centre, we observe one or more foramina which pass entirely through them.

§ 599. They articulate, 1st, with each other by a rough and very broad surface, which is usually extended into a crest or spine, called the *nasal crest* or *spine* (*crista*, s. *spina nasalis*); 2d, with the ethmoid bone, directly, by the nasal spine, or indirectly, by a piece of bone interposed between them, which also represents a spine; 3d, with the frontal bone (§ 568) by their upper and thickest edge; 4th, finally, with the anterior edge of the nasal process of the upper maxillary bone, by their outer edge.

§ 600. Each of them is developed by a single nucleus of bone, which begins to appear at the commencement of the third month.

§ 601. Both bones not unfrequently unite in their whole length, or only at their upper part, which deserves to be remarked as offering an analogy with the formation of several simiæ.

V. OF THE UNGUIFORM BONES.

§ 602. The *unguiform* or the *lachrymal bones* (*ossa lachrymalia* s. *unguis*) are the smallest of the bones of the face. They are only thin plates of an oblong quadrangular form, situated in the inner angle of the eye between the maxillary, the frontal, and the ethmoid bones, and are frequently perforated.

Their outer face is divided by a longitudinal crest, to which a depression corresponds posteriorly, into two parts, an anterior and a posterior, the proportional extent of which varies much. The posterior part is sometimes very small, and then the papyraceous plate of the ethmoid bone is rather extensive. When, on the contrary, the anterior is narrower, it is made up by the greater breadth of the nasal process of the upper maxillary bone. The anterior part is always much thinner than the posterior, concave externally and convex internally. It forms the posterior wall of the *nasal channel* (*sulcus canalis nasalis*), the anterior of which belongs to the posterior part of the external face of the nasal process of the upper maxillary bone (§ 581).

* Sandifort, *Obs. anat. pathol.*, b. iii. p. 113, iv. p. 134.
† Spix, *Cephalogenesis*, p. 19.

§ 603. The unguiform bone articulates, 1st, by its upper edge with the orbital portion of the frontal bone; 2d, by its posterior edge, with the anterior edge of the os planum; 3d, downward, by its inferior edge, with the anterior part of the inner edge of the body of the upper maxillary bone; 4th, forward, by its anterior edge, with the posterior edge of the nasal process of this bone. All these edges are thin and smooth. The posterior face of the unguiform bone closes the anterior ethmoidal cells.

§ 604. The ossification of the unguiform bone begins in the fifth or sixth month.

§ 605. The unguiform bone is not unfrequently extremely small or entirely deficient. It is then supplied by the cribriform plate of the ethmoid bone, or more frequently by the ascending branch of the upper maxillary bone, which becomes broader, or finally by both these at once.

VI. OF THE INFERIOR TURBINATED BONES.

§ 606. The *inferior turbinated bones* (*conchæ, conchæ inferiores, ossa turbinata* s. *spongiosa*), thus called to distinguish them from the superior and middle turbinated portions of the ethmoid bone, form a very great part of the base of the olfactory organ.

In form and structure they resemble the ethmoidal turbinated bones, but are larger than them, and are convex externally. They are elongated from before backward, higher in the centre than in the other parts, straight, very thin and smooth in their upper portion, bulging in the lower portion, and terminate downward by a rounded edge which is reflected from below upward. Their inferior portion is rough, and on its external face are tubercles, and small blind depressions on its internal.

§ 607. Near the centre, the upper edge, which is sharp is reflected outward and downward, to produce the broad *unciform maxillary process* (*processus maxillaris*), by which it is joined to the lower edge of the maxillary sinus. In front of this process we perceive another, which varies in length,—the *nasal* or *lachrymal process* (*processus lachrymalis* s. *nasalis*), the direction of which is from below upward; it articulates with the lower extremity of the unguiform bones. Between these two eminences, we sometimes see the *ethmoidal processes* (*processus ethmoidales*), which go to the large and small processes of the ethmoid bone (§ 574).

The anterior and blunter extremity of the bone articulates, 4th, with the lower transverse eminence of the upper maxillary bone (§ 585), and the posterior with the corresponding eminence of the palate bone (§ 590).

§ 608. Ossification appears first in the fifth month, at its centre, where there is only one nucleus. We have never found several.

VII. OF THE VOMER.

§ 609. The *ploughshare* (*vomer*) is an irregularly quadrilateral bone situated on the median line to which it imperfectly corresponds, and downward and backward divides the nasal cavity into two portions. Its upper edge, which is the thickest and also the shortest, is divided into two lateral processes, called the *wings* (*alæ vomeri*), between which is a furrow. These wings embrace the spine of the sphenoid bone, and are covered by the vaginal processes of this bone. The upper and anterior edge, the longest of all, is also cleft, but much thinner ; it is articulated posteriorly with the posterior edge of the perpendicular plate of the ethmoid bone, and forward with the inferior edge of the cartilaginous septum of the nasal fossæ. The inferior, which is the third in extent, articulates with the palatine crest (§ 585). The posterior is free. Thus the vomer articulates with the ethmoid bone, the sphenoid bone, the upper maxillary bones and the palate bones.

§ 610. In the fœtus of four months, there is already formed only a single bone, which is much lower, in proportion to its length, than in the adult, and is composed of two plates, of equal thickness in every part, separated in almost all their height, and united only at their lower part, loose around the cartilage of the septum of the nasal fossæ, and having the appearance of a single plate reflected on itself. It is then proportionally and absolutely much broader than in the adult. This form is found even in the full grown fœtus, where the lateral plates are no where turned outwardly. We have never found several points of ossification, which Portal asserts exist.

§ 611. When the nose is not completely developed, the vomer is sometimes deficient, or is perforated by an opening.

VIII. OF THE LOWER MAXILLARY BONE.

§ 612. The *lower maxillary bone* (*maxilla*, s. *mandibula inferior*, *os maxillare inferius*) is situated opposite the upper. It has a parabolical form, resembling a horse-shoe. We may, for the convenience of study, divide it into the *central, alveolar*, or *horizontal portion* (*pars alveolaris, ramus horizontalis*), and the *articular, lateral* or *ascending parts* (*partes articulares, rami perpendiculares*).

§ 613. These three parts are marked with muscular impressions, which render the surface uneven. In the centre of the anterior and posterior faces of the central portion are two longitudinal eminences, called the *external* and the *internal mental crests* (*crista mentalis externa et interna*). At some distance on this crest, equally on both faces, we perceive on each side a line, the direction of which is almost the same as that of the upper edge : these are called the *external* and *internal oblique lines* (*linea obliqua externa et interna*). This line extends from before backward, to the second small molar tooth.

Below this same tooth, about the centre of the bone, is the *mental* or *anterior maxillary foramen* (*foramen maxillare anticum*, s. *mentale*).

§ 614. The ascending branch is divided upward into two processes, of which the anterior, called the *coronoid process* (*processus coronoideus*), is greater, thinner, and more elevated than the posterior, flattened from without inward, and pointed. The second, called the *condyloid process* (*processus condyloideus*), is broader from one side to the other than from before backward. Its direction is a little oblique from without inward and from before backward, so that the two articular surfaces converge toward each other backward. Its upper face is rounded, and usually divided, by a transverse line, into an anterior and a posterior part.

This process, which is the broadest part of the lower maxillary bone, is about six lines broad from one side to the other; its height and thickness are about three lines. The thick and contracted part which comes after it is its *neck*. The *sigmoid notch* (*incisura semilunaris*, s. *sigmoidea*) is that part of the upper edge which is found between the two processes and the *angle of the jaw* (*angulus maxillaris*) is the place where the posterior and inferior edges are united with each other. A little above the middle of the internal face is a large opening, the *posterior maxillary foramen* (*foramen maxillare posterius*), which leads into the *maxillary canal* (*canalis maxillaris*). This last penetrates into the bone nearer its lower than its upper edge, opens externally by the mental hole, but still continues as far as the median line, and furnishes, at its upper part, some small canals which go to the roots of the teeth. A small fissure proceeds from this posterior maxillary foramen along the internal face, which is called the *mylo-hyoid fissure* (*sulcus maxillæ inferioris*, s. *mylo-hyoideus*). Sometimes, but rarely, this fissure is converted into a real canal, either at its origin or in one or several parts of its course: more rarely still, it divides into two branches at the moment of its origin.

§ 615. The lower maxillary bone does not articulate, except with the temporal bones, on which it moves.

§ 616. We have found this bone formed, in the earliest periods, of but two lateral pieces, united on the median line by a cartilaginous substance. In fact, Autenreith pretends that it develops itself by three or four points of ossification, belonging to the condyle, to the coronoid process, to the horizontal portion, and to the angle.* Even before him, Kerkring said he had found the coronoid process at least, developed separately.† Very recently still, Spix‡ has admitted not only the osseous nuclei pointed out by Autenreith, but has also described and figured a fifth, a plate which closes the alveolar edge internally, and which, according to him, remains separate and distinct until the fourth month. But, however carefully we may have examined even the youngest fœtuses, we have neverfound, either during or after pre-

* Wiedemann, *Archiv. für Zoologie und Zootomie*, vol. i. pt. i. p. 39.
† *Osp. omn. anat.*, p. 233.
‡ *Cephalogenesis*, p. 20.

paration, more than a single plate in each portion of the lower maxillary bone. It is true that the alveolar edge is not closed at first internally by the osseous substance; but there is no special nucleus of bone formed in this part: there is developed a process, the direction of which is from before backward, which becomes an anterior portion of the bone, and is at first separated from it by a small posterior fissure. When it has arrived at the region of the ascending branch, it unites to its internal face by a bridge, and forms the posterior maxillary foramen. In the commencement, the maxillary canal is not yet closed at its upper part, and is connected with the dental edge.

We always find, even in the full-grown fœtus, two openings at least, in the place of the posterior maxillary foramen; one much more ample, leads to a furrow which exists at the bottom of the posterior alveolar process, and which ceases at its anterior extremity. The other, smaller and inferior, leads to a canal which passes under the alveolar process, and which goes to the internal extremity of the half of the jaw. The furrow and the canal communicate by several openings, and all lead to the anterior maxillary foramen; but the furrow more directly.

A pretended line of demarkation, pointed out by Spix, between the plate and the rest of the lower maxillary bone, is only the mylo-hyoid fissure (§ 614), which is extensive in the fœtus, because of the great development of the mylo-hyoid branch of the fifth pair of nerves.

We shall speak of the development of the alveolar edge, when treating of the teeth.

The two lateral parts are straighter and nearer to each other, in proportion to the youth of the bone. The ascending branch, especially the articular process, is more depressed, so that the alveolar edge does not project in the fourth month of pregnancy. There is less difference between the direction of the posterior edge of the ascending branch, and the inferior edge of the horizontal portion; and, also between the anterior edge of the first and the upper edge of the second: and, fourthly, the articular process is contracted from right to left.

In the full-grown fœtus, the lower maxillary bone does not resemble the formation which distinguishes it in the adult, except in regard to the fourth condition. As to the first, the bone, in the early periods of the fœtal state, differs more than the lower maxillary bone of the adult, since its form is then rounder. This, it is true, depends partly on the greater projection of the alveoli; but this circumstance is not the only cause. The maxillary bone, however, is still much flattened at this period; its edges are very round, and the whole bone is very broad. Finally, it is perfectly developed very early, since, in the fœtus of three months even, it is the largest bone in the whole body.

The union of the two lateral portions commences in the first months after birth. Generally, however, in the course of the second year we observe always at the upper edge a small fissure, the direction of which is from above downward, whence the fusion takes place from below upward. This peculiarity is very remarkable, because the bones

situated below the lower maxillary bone, the sternum, and the hyoid bone, also often unite in the median line, while those found above it, the upper maxillary bone and the other accessory bones of the face, remain separate during life; and the lower parts of the two pieces of the frontal bone are also the last in which this fusion takes place.

Sometimes the two portions are already united in the full-grown fœtus; this union, in certain cases, seems to take place at the expense of the formation of the other bones of the head.

Sometimes, also, there is developed between these two halves, either a single bone or two small bones, a right and a left, which unite on the median line: not long since, we observed this anomaly in a child three months old; or, this horizontal branch is divided still farther back into two large halves: a striking analogy with the development of the upper maxillary bone, and with the constant arrangement of the lower maxillary bone in birds, in reptiles, and in the mammalia.

§ 617. The two portions of the inferior maxillary bone do not, to our knowledge, ever continue separated, although this arrangement exists, in the normal state, in many animals, and is a very frequent anomaly in the superior maxillary bone.

An unfrequent anomaly is the union of the articular process with the temporal bone. This prevents mastication.*

IX. OF THE HYOID BONE.

§ 618. The *hyoid bones* or the *hyoid bone* (*ossa hyoidea*, s. *os hyoides*),† forms an arch which is convex forward. It is situated behind and below the lower maxillary bone, at the root of the tongue and at the upper part of the neck. It is generally considered a single bone, and is divided into a central portion or body, and four horns, two on each side. But, as these parts remain distinct through life, it is better to admit five distinct hyoid bones, a middle and four lateral bones.

I. OF THE CENTRAL HYOID BONE.

§ 619. The *central hyoid* bone, or the body (*os hyoides medium*, s. *basis*), the largest of all, is situated transversely.

Its anterior face is slightly convex, and the posterior very deeply grooved.

The anterior face is divided into a larger inferior ascending and uniformly convex portion, and a smaller superior portion which is also arched from right to left, but more or less grooved from above downward, which is also divided into two lateral portions by a small eminence between.

* Sandifort, *Obs. Anat. Pathol.*, vol. I, p. 102, tab. vi. vol. II. p. 117.

† See, on the hyoid bone considered in all vertebrated animals, the memoir on the anterior bones of the chest, by G. F. St. Hilaire, (*Philosophie Anatomique*, p. 139). He admits seven pieces in the hyoid bone of the mammalia, and refers to it also, the styloid processes of the temporal bones. F. T.

The upper and lower edges are sharp, the two lateral are somewhat broader.

At the end of the upper part of the anterior face, there is on each side a small plain articular surface covered with cartilage.

II. OF THE INFERIOR HYOID BONE.

§ 620. The *inferior hyoid bone*, called also the *inferior horns*, the *large horns of the hyoid bone* (*ossa hyoidea lateralia inferiora, cornua inferiora*, s. *magna*), is the direct continuation of the preceding, and forms the largest posterior part of a horizontal arch. Each of the two pieces of which it is composed, is longer than the central hyoid bone, but it is much weaker. Their anterior part is the broadest. They then gradually contract, and terminate backward by a rounded bulging edge. These two pieces usually diverge from before backward, but they rarely incline a little toward each other posteriorly.

Their anterior broader edge is slightly concave and covered with cartilage. The inner end of the upper part of their anterior face has also an articular facet, which is smooth and covered with cartilage.

They often, in the same subject, vary considerably in form and size on the different sides.

They articulate with the central piece by a fibro-cartilaginous mass, and sometimes unite in the later periods of life in one bone.

III. OF THE SUPERIOR HYOID BONE.

§ 621. The two pieces of the *superior hyoid bone*, called also the *superior* or *small horns of the hyoid bone* (*ossa hyoidea*, s. *cornua superiora* s. *minima*), have a more or less rounded and oblong form. They gradually grow thin from one extremity to the other; are oblique from below upward, and from within outward; and are situated in the place where the middle and inferior bones unite, being connected with them by a loose capsular ligament.

They are always very thin, and usually much shorter, but sometimes also much longer, than the inferior bones. Their length varies from two lines to an inch and a half. In the latter case, it often but not always happens, that each is composed of two separate pieces.

Of all bones, these present the greatest differences in respect to form and length, not only in different individuals, but also in both sides of the body in the same individual. We not unfrequently find them twice as long on one side as on the other, and this side is almost always the left, at least according to our observations. We have never found this to be the case on the right side, although we have examined many hyoid bones.*

§ 622. The hyoid bones articulate with one another at the places pointed out (§ 619, 620, 621), and farther upward, with the styloid

* The remark, that this arrangement is constant, is more probable, because Duverney has made the same remark.—(*Comm. Petrop.*, vol. vii. p. 216).

process of the temporal bone, downward with the centre of the upper edge and the superior horns of the thyroid cartilage.

§ 623. They begin to ossify about the end of pregnancy, and sooner in the lower lateral hyoid bones than in the central bone. The upper lateral hyoid bones do not ossify till several months after birth.

§ 624. These bones continue on the neck, the chain of bones formed in the head by the lower maxillary bone ; in the chest, by the ribs and sternum ; in the pelvis, by the symphysis pubis. We may then consider them as corresponding to the ribs and sternum, and call the central part the *bone of the neck*, and the lateral parts the *cervical ribs*.

CHAPTER III.

GENERAL REMARKS ON THE BONES OF THE HEAD.

§ 625. The bones of the head (*ossa capitis*), taken collectively, may be considered, 1st, in regard to the general form of the whole, and the differences in respect to age, sexes, and races ; 2nd, as regards the characteristics of certain parts of the head, to produce which, several bones concur, having regard principally to the relations between these parts and the other organic systems.

I. REMARKS ON THE GENERAL FORM OF THE HEAD.

§ 626. The head has, as a whole, a rounded form. This however is more evident in the skull than in the face ; for this last resembles, properly speaking, an irregular square, furnished however with numerous depressions and elevations, of which we see but slight traces, so long as the portions of the other organic systems which cover them are not removed. Further, the skull itself is not round and regular. Its anterior, superior, posterior, and lateral portions, are, it is true, plain and smooth, except a few inconsiderable asperities ; but its lower part, or the *base* (*basis cranii*), is extremely irregular, because of numerous muscular impressions, and large or small holes, through which pass vessels or nerves, of which we find but slight traces in its other regions.

The skull contains a cavity, generally enclosed with very thin walls, which is convex externally and concave internally in the different regions which have been mentioned. The internal face corresponds with tolerable exactness to the external. On the contrary, not only its lower part is not uniformly concave internally, and convex externally, but the external and internal faces do not correspond.

The general differences between the external and the internal faces of the skull depend on their relations with the organs with which both are connected.

1st. The greater part of the internal face, especially the anterior part of the base, presents numerous digital depressions and mammillary eminences (§ 526).

2d. On the internal face of the lateral and superior parts, numerous fissures (*sulci meningei*) arise from the middle part of the base, in which are situated the cerebral arteries.

3d. This same face presents other fissures for the veins (*sulci venosi*), which are broader, and are situated in the upper part of the skull on the median line; and in the lower part, on both sides of this line, they are the traces of the sinuses of the dura mater.

4th. The internal wall of the base presents several depressions, which are the largest of any, and which correspond to the different divisions of the encephalon.

The elevations and projections which render the internal face uneven, serve partly for the attachment of the dura mater. Others circumscribe several of the depressions which we have mentioned; and others still, as the petrous portion of the temporal bone, possess an independent existence.

§ 627. The form of the skull is not exactly round. If cut perpendicularly and horizontally, it represents ellipses, of which the greater diameter is backward, the smaller forward. The skull is much longer from before backward, than from right to left and from above downward. The proportion between its greatest length from the glabella of the frontal bone to the spine of the occipital bone, its greatest breadth from the squamous portion of one temporal bone to that of the other, and its greatest height is nearly : : 3.3 : 2.3.

If we examine the interior of the skull, we perceive that this cavity, uniform in parts, divides, especially downward, into three portions, situated successively from before backward, the *anterior*, the *middle*, and the *posterior*.

The *anterior*, which is the smallest in every dimension, occupies the most elevated region. Its sides are formed by the orbital portions of the frontal bone; its centre by the central part of the ethmoid bone, and its posterior part by the small wings of the sphenoid bone. Forward, and on the sides, it is imperceptibly continuous by a rounded edge with the lateral faces of the skull; while backward it is separated from its central part by a sharp and grooved edge. Its form is then almost semicircular. Downward, on both sides, where it forms the roof of the orbits, it is strongly bulging, and projects into the cavity of the skull, while it presents a considerable depression in almost all its central portion, which is formed forward principally by the cribriform plate of the ethmoid bone. The crista galli process (§ 571) arises from its centre; before this the internal frontal crest arises (§ 564), between which and the process is the *foramen cæcum* (§ 566).

The anterior extremities of the anterior lobes of the cerebrum and the olfactory nerves, the threads of which pass through the holes of the cribriform plate, rest upon this portion. To the crista galli process and to the frontal ridge is attached the lower anterior extremity of the large falx of the dura mater.

The central portion, which deserves this name both from its situation and from its extent, has the form of a figure 8 placed trans-

versely (∞), for it is much narrower in the centre than on the two sides. It is formed by the body, the large wings and the posterior and inferior portions of the small wings of the sphenoid bone, and by the squamous and the large anterior part of the temporal bones. Its anterior edge, formed by the small wings of the sphenoid bone, consists in two large lateral arches and a central arch which is smaller; the lateral is insensibly continuous with the lateral face of the cranium; the posterior is composed of a central, smaller, and straight portion, the upper edge of the sloping part of the sphenoid bone, and of two much more extensive, sharp, and almost straight edges, which proceed from within outward and from before backward, the upper angles of the petrous portion of the temporal bone. This portion is grooved, but its central part, the sella turcica, is much more elevated than the lateral portions, which are more extensive than it.

In its centre is situated the pituitary gland, and on the two sides the anterior part of the posterior lobes of the brain.

The posterior portion, which is the largest of all, has an almost circular form. It is for the most part composed of the occipital portion of the basilar bone, forward and on the sides by a small part of the temporal and of the sphenoid bones. The posterior edge of the second portion separates it from the last forward. In every other direction it is gradually continuous with the other walls of the skull.

It lodges the cerebellum, the medulla oblongata, and the inferior part of the venous sinuses of the cerebrum. The anterior edge of the tentorium is attached to its anterior and sharp edge.

§ 628. The base of the skull, considered in regard to its external and its internal faces, ascends from its posterior to its anterior portion, which is the larger. The first is formed by the posterior and inferior part of the squamous portion of the occipital bone. The occipital foramen is situated almost horizontally a little behind the centre. After leaving this point the body of the sphenoid bone suddenly rises, then curves forward above the sella turcica: this last is almost horizontal. From thence the internal face of the base of the skull divides into an upper and inner and an outer and lower portion. The first elevates itself again, but slightly, before the anterior edge of the sella turcica; the second, which comprises the wings of the sphenoid bone and the lower part of the ethmoid bone, turns perpendicularly downward, to assist in forming the nasal fossæ.

§ 629. The facial portion of the head represents a very irregular square or triangle, which is much higher forward than backward, and is situated below the anterior half of the cranium, extending a little in front of it. Of the fourteen bones which compose it, thirteen are firmly united, either with each other or with the adjacent bones of the skull, by broad dentated surfaces, by sutures, or by smooth, sharp edges. One alone, the lower maxillary bone, is moveably articulated with the temporal bones.

Instead of a single large cavity, like that of the skull, the bones of the face, form (not however alone, but with those of the skull) other

and more open cavities and depressions, which are connected with the radiations of the nervous system the organs of sense, or with the moveable organs of mastication.

The cavities of the first kind are situated forward; those of the second are found on the side, and are farther backward. The first are the cavities of the orbits, the nasal fossæ, and the cavity of the mouth; the second are the temporal fossæ.

I. OF THE ORBITS.

§ 630. The *orbits* (*orbitæ*) have the form of truncated, short pyramids with unequal faces, of which the very broad and almost perpendicular base looks forward, and is directed a little from before backward and from within outward, while the summit corresponds to the posterior extremity. Both orbits converge very much backward, so that they are for the most part, if not entirely, turned forward, and a little outward.

The outer and lower faces are straight. The internal and the upper, especially the latter, on the contrary, are very concave.

The upper face, called the *vault of the orbit* (*lacunar orbitæ*), is formed, in most of its anterior part, by the orbitar portion of the frontal bone. We observe, in a small part of its posterior portion, the inferior face of the small wing of the sphenoid bone. It is insen ibly continuous, by a rounded edge, with the internal and the external walls of the orbits.

The external wall in the direction of length is oblique from without inward and from before backward, in that of height it is directed from without inward and from above downward, and its length exceeds its height very much. Its anterior and smaller part is formed by the malar bone, and the posterior and larger portion by the large wing of the sphenoid bone; it is separated backward and upward from the upper by the superior sphenoid fissure, backward and downward by the inferior sphenoid fissure.

The lower face is irregularly triangular, and mostly formed by the upper face of the body of the upper maxillary bone, forward by the malar bone, and inward by the orbital portion of the palate bone. It descends a little from behind forward and from within outward.

The inner face is formed at its central part, which is the most extensive, by the lateral plate of the ethmoid bone, forward by the lacrymal bone, and backward in a small portion by the body of the sphenoid bone. Its direction is a little from before backward and from within outward, and it descends obliquely downward and outward.

The nasal canal commences at its anterior extremity.

The anterior opening of the cavity of the orbit is almost quadrilateral; its breadth, however, exceeds its height, and it is circumscribed by rounded, grooved edges, which are insensibly continuous with each other.

This cavity is connected with the *cavity of the skull*, with the *nasal cavity*, with the *pterygoid fossa*, and with the *anterior part of the face*.

1st. With the cavity of the skull, by the optic foramen, which is found at its posterior extremity, always a little within its axis (§ 541); more anteriorly, by the superior sphenoid fissure (§ 541); forward, by the anterior and posterior ethmoid foramina (*foramina ethmoidalia anteriora et posteriora*), situated between the orbital part of the frontal bone and the upper edge of the os planum of the ethmoid bone.

2d. With the nasal fossa, by the anterior ethmoid foramina and the nasal canal.

3d. With the pterygoid fossa, by the inferior sphenoidal fissure.

4th. With the anterior part of the face, by its large anterior opening, the infra-orbital canal, and the foramina of the malar bone.

§ 631. Seven bones concur in its formation, viz., the frontal bone, the sphenoid bone, the upper maxillary bone, the malar bone, the palate bone, the ethmoid bone, and the unguiform bone.

§ 632. In youth the orbits are proportionally deeper, and their walls are more concave; the internal, which does not even exist in the fœtus, is much lower; the inferior is concave and almost straight, or less oblique from above downward, and from behind forward; finally, the anterior opening is more or less transversely elongated. Considered as a whole, the breadth of the orbital fossa exceeds its height very much. Its external edge, formed in a great part by the malar bone, projects very much from above downward and from behind forward, while afterwards it descends almost perpendicularly. These remarkable differences are greater in proportion as the fœtus is younger. They depend on the fact that the face is at first low, and lengthens gradually.

II. OF THE NASAL FOSSÆ.

§ 633. The *nasal fossa* (*cavum nasi, nares internæ*)* is situated below and between the two cavities of the orbits (§ 624—629); but it extends also above them, by some of its prolongations. It has a very irregular form; it is however on the whole quadrangular, and similar to the form of the face. A *perpendicular septum* (*septum narium*), directed from before backward, divides it in its broadest part into two halves, a right and a left. We may divide it into the *proper nasal fossa*, and into *secondary* or *accessory cavities*.

§ 634. In the *proper nasal fossa* we distinguish an anterior and a posterior opening, the floor, the upper wall or the vault, and the lateral walls. The accessory cavities comprehend the three nasal sinuses.

The *anterior opening* (*apertura narium anterior*, s. *faciei pyriformis*) is elongated and pyriform. It terminates in a point at its upper part, enlarges downward, but again contracts towards its inferior extremity. It is single, because the bony septum does not extend entirely forward. The lines which circumscribe it are always arched externally. It is

* Ziervogel, *Diss. de naribus internis*, Upsal, 1760.

not exactly perpendicular, but, regarded from above downward, it projects a little backward. At its lower part it projects a little from without inward, and from behind forward, and in the middle of the inferior edge we see the *anterior nasal spine* (*spina nasalis anterior*). It is formed above by the inferior edge of the nasal bones, and in almost all its lower part by the nasal process and the body of the upper maxillary bone.

The *posterior aperture* (*apertura nasalis posterior*) is lower, but much broader than the anterior. It represents a somewhat regular square, and is always double, because the septum, which terminates by an oblique and serrated edge, extends to the posterior extremity of the nasal fossa. It is formed by the inner plate of the pterygoid processes of the sphenoid bone, the vomer, and the horizontal portion of the palate bone.

The *floor* of the nasal fossa is almost straight, and slightly concave, for it is a little elevated on each side, internally and externally, toward the septum and the lateral walls. It terminates forward in a triangular edge, and backward in another edge semicircular on both sides, having two deep notches. We observe in the centre of the first the anterior nasal spine, and in the centre of the second the posterior nasal spine. The floor is formed by the horizontal part of the upper maxillary and palate bones.

The upper wall, which is the smallest, is formed upward, by the cribriform plate of the ethmoid bone, downward by the frontal bone and the nasal bones.

The posterior wall exists only at the summit of the nasal fossa, and is formed by the sphenoid bone.

The lateral walls of the nasal cavity are very irregular. They elevate themselves in an almost straight direction, but generally are a little convex externally, and present on their internal portion considerable projections, which render the surface very uneven, and also openings which lead into the accessory cavities.

The direction of the eminences projecting internally is from before backward. They are convex internally, concave externally, and are situated one above the other. Their upper edges are attached, and their lower edges are free. We usually count three: 1st, the *upper*; 2d, the *middle turbinated portion of the ethmoid bone* (§ 572); 3d, the *inferior turbinated bone* (§ 606). We usually remark, besides, a smaller process, situated at the upper and posterior part,—the *upper turbinated portion of the ethmoid bone.*

The depressions or semi-canals between these projections, which are directed from before backward, and always ascend from behind forward, are the *superior*, the *middle*, and the *inferior* meatuses of the nose, which extend equal distances backward, but not forward.

The *superior meatus* is generally found between the upper and the middle turbinated bones. It is the least elevated, the narrowest, and the shortest, for it does not project forward as far as the two others. The sphenoidal sinuses open into its posterior part; the cel-

lules of the ethmoid bone, of the palate bone, and of the upper maxillary bone, in its central part.

The *middle meatus* is much higher, and is the most uniform of the three in its height. It extends between the middle and the inferior turbinated bones, projects much farther forward than the upper, and receives in its anterior portion the frontal sinuses, and in its centre the maxillary sinuses.

The *inferior meatus*, the longest of all, is higher in its anterior part, but much lower in its posterior part than the middle meatus, and is situated between the inferior turbinated bone and the floor of the nasal cavity. It communicates with no accessory cavity; the lachrymal duct, however, opens in its anterior extremity.

Besides these three channels, we always remark a fourth longitudinal depression, between the superior turbinated bone and the whole internal wall of the labyrinth and of the cribriform plate; this depression extends much farther forward than the superior meatus. Finally, we usually discover a fifth, which is much smaller, the most superficial and the shortest of all, between the most superior and the upper turbinated portions of the ethmoid bone.

§ 635. The nasal fossa sends upward, on the two sides and backward, several *processes, prolongations*, or *accessory cavities (sinus antra)*.

1st. The upper prolongations are the *frontal sinuses* (§ 564), which open into the middle meatus by an orifice, which gradually narrows, and the direction of which is from before backward and from above downward.

2d. The lateral prolongations are the *maxillary sinuses* (§ 534), the largest; they open by a very narrow orifice in about the centre of the middle meatus.

3d. The posterior are the *sphenoidal sinuses* (§ 536), which also open by a narrow orifice into the posterior part of the superior meatus.

§ 636. The nasal cavities communicate upward with the orbits and the cavity of the skull by the orbital holes, and with the cranium by openings in the cribriform plate; backward, with the pharynx, by their posterior openings; forward, with the cartilaginous nasal fossæ, by their anterior openings; downward, with the oral cavity, by the anterior palatine foramen.

§ 637. They are formed by nine different bones: 1st, the upper maxillary bones; 2d, the palate bones; 3d, the sphenoid bone; 4th, the ethmoid bone; 5th, the inferior turbinated bone; 6th, the vomer; 7th, the nasal bones; 8th, the unguiform bones; 9th, the frontal bone. Of all these, the upper maxillary bones contribute the most to their formation, as they form most of the floor and of the lateral walls. The ethmoid bone belongs to them entirely, forming their upper wall. The palate bones complete their floor, and contribute to form their lateral walls. The unguiform bones form part of their lateral walls, as does also the inferior turbinated bone. The sphenoid bone concurs to form the posterior part of the posterior wall and the lateral walls, by its pterygoid processes and its sinuses. The frontal bone and the nasal bones

terminate their upper wall forward. Finally, the vomer forms the inferior and posterior part of the septum of the nose, while its upper wall is composed of the perpendicular plate of the ethmoid bone and of the spine of the sphenoid bone.

§ 638. The nasal fossæ are much less spacious, proportionally speaking, in the early periods of life. From the smallness of the whole face, they are much lower and narrower, so that their anterior and posterior openings are proportionally much broader and lower; for the height of the posterior is one half greater than its breadth, the anterior in the full grown fœtus is not more than one half as broad as it is high and its shape is not pyriform, but irregularly quadrilateral; and again, the ethmoid cellules and the accessory cavities are not entirely developed at first, but acquire their normal size only at puberty.

In the early periods of life, and at the commencement of the third month of fœtal existence, the nasal fossæ are not entirely separated from the oral cavity at their lower part, for the floor gradually develops itself from without inward.

III. OF THE ORAL CAVITY.

§ 639. The bony *oral cavity* is a parabolic space, convex forward, terminated posteriorly by a straight edge, and situated below the nasal fossæ, from which it is separated by their floor (§ 631). The lower face of this last forms what is called its *roof* or the *bony palate* (*palatum osseum*, s. *stabile*), which is slightly concave and almost quadrangular. The anterior and lateral parts of the walls of the oral cavity, which are insensibly continuous with it, are formed upward by the alveolar edge of the upper maxillary bone, a small part of their posterior portion by the broader extremity of the pterygoid processes, and downward, by the whole inferior maxillary bone. A posterior and inferior wall does not exist, so that the bony cavity of the mouth is entirely open in this direction. The lateral walls are separated by a large hollow, which divides them into an upper and a lower part; for the lower maxillary bone is not united to the other bones of the head, but is moveably articulated with the temporal bone (§ 533, 615), so that the oral cavity may open and close at different degrees in front, and it may vary considerably in height in all its extent. This peculiarity distinguishes it from all the other cavities of the head.

§ 640. This cavity is formed by four bones, the upper and lower maxillary bones, the palate bone, and the sphenoid bone. It is connected posteriorly with the pharynx, anteriorly with the anterior part of the face, by the mouth; finally upward with the nasal fossæ, by the anterior palatine foramen, and with the pterygoid fossa by the posterior.

§ 641. Like the nasal fossæ it is lower the younger the subject is, as the teeth are not yet developed, and from the shortness of the ascending process of the upper maxillary bone it is proportionally shorter and broader.

IV. OF THE TEMPORAL FOSSA.

§ 642. The *temporal fossa* (*fossa temporalis, jugalis, zygomatica*) is the inferior and anterior somewhat contracted part of the lateral surface of the skull and the face.

It is open on all parts upward, backward, and downward, and also outward in most of its extent, and even on this point it is but imperfectly closed near the centre of its height by an almost transverse eminence, the direction of which is from before backward and slightly arched outward, which passes over it like a bridge. This is the *zygomatic arch* (*zygoma, arcus zygomaticus, jugalis*) which extends from the temporal bone to the face, or, to speak more precisely, to the upper maxillary bone.

It is much flatter at its upper than at its lower part, where it is depressed inward. Its internal wall descends at first a little obliquely from without inward, but in its lower portion it is perpendicular. The anterior is almost straight and very slightly grooved. The zygomatic arch anteriorly is broader than it is posteriorly.

§ 643. The temporal fossa is formed from four bones, viz. 1st, the sphenoid bone ; 2d the temporal bone ; 3d, the upper maxillary bone ; and 4th, the malar bone. The larger and under wing of the sphenoid bone constitutes almost all of its inner wall ; the upper and posterior part, which is less extensive than the rest, is formed from the anterior part of the squamous portion of the temporal bone. The zygomatic arch is formed by the zygomatic process of the temporal bone, and by the malar bone. This last and the upper maxillary bone form the anterior wall of the fossa.

§ 644. The temporal fossa communicates with the orbit by the inferior sphenoidal fissure, with the pterygoid fossa by the pterygo-palatine channel, and with the oral cavity by the posterior palatine foramen.

§ 645. The temporal fossa, from the greater breadth of the skull and the lowness of the face in the early periods of life, is much lower, planer, and narrower from above downward and from within outward, but longer on the contrary from before backward than in the adult.

II. COMPARISON OF THE BONES OF THE HEAD WITH EACH OTHER, AND WITH THE OTHER BONES.

§ 646. The bones of the head differ very much from each other, and from the other bones of the body, in regard to their forms ; there are however great traits of analogy between them and the latter. Certain bones of the skull, considered separately, or several together, more or less evidently resemble the vertebræ.*

* J. P. Frank first recognized the analogy between the skull and the vertebræ (*Sammlung auserlesener Abhandlungen*, vol. xv. p. 267 ; *Epit. de curandis hom. morbis*, b. ii. p. 42) ; he deduced it from the relation between the brain and the spinal marrow. Burdin (*Cours d'études médicales*, Paris, 1803, vol. i. p. 16) also thought that the head is only a vertebra more complicated than the others. This was also the opinion of Keilmeyer (A. L. Ulrich, *Annotationes quædam de sensu ac signifi-*

We must regard the occipital portion of the basilar bone considered as one bone, the sphenoid portion united to the frontal bone, and the two temporal bones taken collectively with the parietal bones, as forming three systems, each corresponding to a vertebra, so that the skull is composed very evidently of three vertebræ, placed one after another from behind forward. It is easy to demonstrate the justice

cutione ossium capitis, Berlin, 1816, p. 4). But as J. F. St. Hilaire remarks it was necessary to have had as clear an idea of this analogy as we now possess to discover it in the midst of a series of foreign ideas, among which it was thrown as if by accident. Duméril has developed this idea still farther (*Considérations générales ur l'analogie qui existe entre tous les os et les muscles du tronc dans les animaux*; in the *Magasin Encyclopédique*, 1808,, vol. iii). Having attended to the articular surfaces to which the muscles of the spine were attached in man and the mammalia, he thought he could perceive that the posterior parts of their skull presented eminences, processes, depressions, and cavities like the posterior parts of the vertebræ, whence he concluded, in his public essay, that the head is a vertebra immense in its dimensions. He established that the occipital hole corresponds to the spinal canal, of which it is the origin; that the basilar process, and very often the body of the sphenoid bone, correspond, in their structure and uses, to the bodies of the vertebræ; that the condyles represent their articular facets; that the occipital protuberance and the spaces below it are analogous to the spinous processes and their bony plates; finally, that the mastoid processes are exactly like the transverse processes. Thus Duméril presented his *theory of analogies;* but the exact resemblance which he had perceived was scarcely remarked or at least appeared but trifling, doubtless because it did not coincide with the exact and consequently too confined meaning attached to the word *vertebra*. At the same time, the German anatomists were led to the same views by comparative anatomy. The celebrated Goethe conceived the idea that the head contained several vertebræ (*Zur Naturwissenschaft*, vol. i. p. 250); he admitted six of them, three of which, the occipital, the anterior and the posterior sphenoid vertebræ envelop the brain, and the other three, the palatine, the superior maxillary, and the intermaxillary vertebræ, comprise that portion of the face in which the organs of sense are situated. Oken (*Ueber die Bedeutung der Schädelknochen*, Jéna, 1817) admits three cephalic vertebræ, the *auricular*, composed of the occipital bone, to which is attached the petrous portion of the temporal bone, the styloid process of which corresponds to the sacrum, and the hyoid, which represents the pelvis; the *maxillary*, of which the posterior sphenoid forms the body and also the transverse and oblique processes, and the parietal bones the spinous process, which also represents the upper and lower extremities, since the squamous portion stands in the place of the scapula and the iliac bone, the pterygoid process, of the clavicle, the malar bone, of the arm and the fore-arm, the upper maxillary bone, of the hand and fingers, the intermaxillary bone, of the thumb, the maxillary condyle, of the femur, the coronoid process, of the leg, and the anterior part of the bone, of the foot. The *ocular*, composed of the anterior sphenoid; its spinous process is the frontal bone; while the vomer, the ethmoid bone, the inferior turbinated bones, the palate bones, and the nasal bones unite to represent the thorax. These ideas have been brought forward and modified by Oken (*Isis*, 1820, No. 6, p. 552; *Esquisse d'un système d'anatomie, de physiologie et d'histoire naturelle*, Paris, 1821, p. 41). In this last treatise the author increases the number of the cephalic vertebræ to four, viz. 1st, the *auricular* vertebræ, which has for its body the basilar process, for transverse processes the lateral occipital, and for a spinous process the upper occipital process; 2d, the *lingual* vertebra, having for a body the posterior sphenoid, and for a spinous process the parietal bones; 3d, the *ocular* vertebra, having for a body the anterior sphenoid, for transverse processes the small wings of the sphenoid bone, and for a spinous process the frontal bone; 4th, the *nasal* vertebra, having for a body the vomer, for transverse processes the ethmoid bone, and for a spinous process the nasal bones. According to him, the extremities may also be traced in the head, to wit, the arms in the upper maxillary bones, and the feet in the lower maxillary bone. All these views have been adopted and the last especially fully developed by J. B. Spix (*Cephalogenesis, seu capitis ossei structura, formatio et significatio per omnes animalium classes, familias, genera et ætates digesta*, Munich, 1815). Spix not content with calling the cranium a prolongation of the vertebral system, considers it a second formation representing all its parts, so that according to him, the being is formed by two complete sections, the one anterior and restrained in its

of this analogy in regarding the forms, the mode of development, and the functions of these pieces of bones.

1st. The analogy is no where more evident than in the occipital portion of the basilar bone. This bone forms, like every vertebra, a ring, of which the central part is thick and spungy, while the lateral

development, the head; the other posterior, and uninterruptedly developed, the trunk: and as the latter has its extremities, the limbs, so the skull has similar extremities, the component parts of the face. Farther, he admits but three cephalic vertebræ, called the *occipital*, the *parietal*, and the *frontal* vertebræ, from the parts which predominate, or the *cranial*, the *thoracic*, and the *abdominal* vertebræ, from the parts of the trunk to which he supposes they correspond, or finally, the *anterior*, the *central*, and the *posterior* vertebræ, also from the analogies which he admits between the different parts of the head and trunk; so that reserving the face, he avails himself of three corresponding sections, the *anterior*, the *central*, and the *posterior*, to form the appendages or the extremities of the cephalic portion of the animal. According to him the first cephalic vertebra, the *occipital*, presents all the parts of the pelvis in the temporal bones; and all those of the inferior limbs in the lower maxillary bone; the squamous portion of the temporal bone is the illium, the small bones of the carare the pubis, and the ring of the tympanum is the ischium; the maxillary condyle corresponds to the femur, the coronoid process to the tibia, the angle to the fibula, the tubercle above the posterior dental canal to the tarsus, the internal oblique line to the metatarsus, the alveolar process to the phalanges, and the teeth to the nails. In the second cephalic vertebra, the nasal bone corresponds to the sternum, the malar bone to the scapula and to the clavicle, and the upper maxillary bone contains all the parts of the upper extremity; finally, in the third, the ethmoid bone represents the cricoid cartilage, the unguiform bone the thyroid cartilage, the palate bone and the internal wing of the pterygoid process the hyoid bone. Ulrich *(Loc. cit.)* continues these researches, but does not compare the jaw except to the upper limbs, and does not trace the inferior extremities in the head.

Cuvier (*Régne animal*, vol. i. p. 73) adopts the principle of the analogy between the head and the spine, neglecting always the term vertebræ, and admitting but three vertebræ, or, to use his own expression, *rings* (*ceintures*), of the skull, the *anterior* of which is formed by the two frontal bones and the ethmoid bone, the *central* by the parietal bones and the sphenoid bone, the *posterior* by the occipital bone. Blainville also recognizes this principle of analogy (*Bulletin de la soc. phil.* 1816, p. 111, and 1817), and declares himself in favour even of the accessory comparisons established by Oken and Spix, at least as far as we can judge from the vague manner in which he expresses himself. Carus gave a new support to the doctrine of the three cranial vertebræ, by dividing the brain itself into three distinct portions and endeavouring to determine the bones belonging to each of them in the vertebrated animals. His work also is one of the most extensive which has been published on this subject (*Lehrbuch der Zootomie*, Leipsic, 1818, p. 164). Meckel (*Beytræge zur vergleichenden Anatomie*, vol. ii. p. 74—82), proposes to consider the whole sphenoid bone as a second vertebra, to make the third in the ethmoid bone and the frontal bone, and to regard the temporal bone as a vertebra cut in two. Schultz (*De primordiis systematis ossium et de evolutione spinæ dorsi in animalibus*, Halle, 1818, p. 13) refuses to admit any analogy between the bones of the face and the vertebræ. Bojanus (*Isis*, 1818, p. 301; 1819, p. 1361), admits four cephalic vertebræ, the first or the *auricular*, the second or the *gustative*, the third or the *ocular*, and the fourth or the *olfactory*, the body of which he formed in the vomer, the axis in the ethmoid bone, and the spinous process in the nasal bones. At the same time, he considers the hyoid bones as the ribs of the first, the pterygoid processes as those of the second, the external wings of these same processes as those of the third, and the bones of the palate as those of the fourth. Finally, he traces the upper extremities in the mastoid, the tympanal, the squamous, the malar, and the upper maxillary bones, and the lower extremities in the lower jaw. Burdach (*Vierter Bericht von der anatomischen Anstalt zu Kœnigsberg*, Leipsic 1821) endeavours to prove there are but three cephalic vertebræ and that the other bones of the head are only secondary parts of vertebræ. Finally, J. F. St. Hilaire, wishing to settle so many uncertainties, asserted that we ought to begin by determining strictly the characters and the conditions of a vertebra. Neglecting the conditions founded on adults and assuming higher considerations, he demonstrated,

and posterior portions are thin and extended in processes; a rounded opning exists in it through which a portion of the central mass of the nervous system passes.

Its squamous portion and its condyloid parts correspond perfectly to the semi-arches, and the basilar process to the body of the vertebra,

that a vertebra is not simple a transverse section placed against other transverse sections, thus producing an accumulation of parts to which as a whole the term column is applied; in a word, that it is not a single bone, but an osseous system formed of nine elements, which may or may not be united, and essentially continue the same (*Considérations générales sur la vertèbre*; in the *Mémories du Muséum*, vol. ix. p. 89.—*Sur le système intra-vertébral des insectes*, in the *Annales de la médecine physiologique*, vol. ii. p. 233). These elements are an unmated and central nucleus, the *cyclèal*, to which are adapted two rings, an upper and a lower, which contain the first, a section of the medullary system, and the second, one of the sanguineous system. Each of these rings is composed of four pieces, namely, the upper of two *périal* and two *épial*, and the inferior of two *paraal* and two *cataal*. In general, one of the two increases always at the expense of the other and when the excess is extreme, the elements of the smaller ring appear as very small processes. Like the difference between the two extremities of the central axis of the nervous system, one of which is attenuated, the other, on the contrary, increased and enlarged like a ball, this difference not only requires an increase in the surface of the principal pieces, but also, and with equal influence, the concurrence of all of them which must then combine uniformly, without any dismemberment of external parts of projections, that is, simply become pieces of the external septum. J. F. St. Hilaire thus explains the defect of projections and processes, which forms one of the distinctive characters of the largest skulls. The osseous system having then only to enclose a medullary mass, it maintains as few external relations as possible, while farther on, having to protect only a very small mass, the spinal marrow, it becomes rough externally, and all its superficial points are formed of strong processes for each muscular part. Leaving these general ideas, to which it was necessary to arrive to determine this question, and to deduce true philosophical conclusions in regard to the cephalic bones, J. F. St. Hilaire concludes (*Composition de la tête osseuse de l'homme et des animaux*, in the *Annales des sciences naturelles*, vol. iii. p. 173) to consider the head, leaving out the lower jaw, as formed of seven vertebræ, which are named and composed as follows: 1st, the *cerebelloid* (*cérébelleuse*) *vertebra* comprising the *basi-sphena* (the posterior segment of the basilar bone), two *superoccipital* (the upper occipital bones), two *stapedial* (the stapes), two *ex-occipital* (the lateral occipital bones), and two *incudal* pieces (the incudes); 2d, the *auricular vertebra*, comprising the *otosphenal* (anterior section of the basilar bone), two *parietal*, (the parietal bones), two *tympanal* (the rings of the tympanum), two *petrous* (the petrous portion of the temporal bones), and two *malleolar* (the mallei); 3d, the *optic* or *quadrijumal vertebra*, comprising the *hyposphenal* (the posterior body of the sphenoid bone), two *cotylèal*, two *pterygoid* (the large wings of the sphenoid bone), two *temporal* (the squamous portion of the temporal bone), two *serrial* (the large portions of the tympanum); 4th, the *cerebral vertebra*, comprising the *ento-sphenal* (the anterior body of the sphenoid bone), two *ingrassial* (the wings of Ingrassias), two *ab-orbital* (the orbital portions of the maxiliary bone), two *jugal* (the malar bones), two *horizeal* (the internal pterygoid processes); 5th, the *ocular vertebral* comprising the *ethmosphenal* (the body of the ethmoid bone), two *frontal* (the frontal bones), two *ad-gustal* (the external pterygoid processes), two *palpebral* (the tarsal cartilages), and two *ethmophysal* (the upper turbinated bones); 6th, the *nasal vertebra*, comprising the *rhinosphenal* (the plate of the ethmoid bone), two *nasal* (the bones of the nose), two *palatal* (the palate bones), two *lachrymal* (the unguiform bones), two *rhinophysal* (the inferior turbinated bones); 7th, the *labial vertebra* comprising the *protosphenal*, two *ad-nasal* (the intermaxillary bone, two *vomeral* (the vomer), two *addental* (the dental parts of the maxillary bone), and two *protophysal* (the cartilage of the nose). As to the lower jaw J. F. St Hilaire says, independently of the seven cephalic vertebræ, admits in each of these branches seven pieces at most, viz. the *subdental*, the *sublachrymal*, the *subpalpébral*, the *subjugal*, the *subtemporal*, the *subrupial*, and the *sub-occipital*. Thus, according to him, the head is composed of seventy-seven bones, the skull and face of sixty-three pairs, and seven which are unmated, and the lower jaw of seven pairs.

F. T.

in regard to form and situation. The squamous part represents the spinous process, and the condyloid portions are analogous to the transverse and articular processes.

The different parts of which it is composed are developed like those of the vertebræ; the squamous and the condyloid portions appear before the body, and the different pieces which form the posterior and lateral portions fuse together before they unite to the body.

The body unites with the central portion of the sphenoid bone forward, and its lateral parts articulate with the cervical vertebra backward, in the same manner as do the analogous portions of the vertebræ with each other.

Similar muscles are attached to the occipital bone and the different vertebræ. So too this bone contains like each vertebra a part of the central portion of the nervous system. Between it, the first vertebra backward and the temporal bone forward, we find the same foramina as between the other vertebræ, and these holes give passage to the same nerves and vessels.

As the bodies of the other vertebræ most generally fuse with each other in some parts at an advanced age, so the bodies of the occipital and the sphenoid bones always unite in a single bone. Their fusion however takes place sooner. Finally, as the last lumbar vertebra often unites to the sacrum, so the occipital bone tends very much to unite in different ways with the first cervical vertebra.

2d. The sphenoid portion of the basilar bone and the frontal bone taken together, represent the second of the anterior vertebræ composing the skull. We may also consider them as composed of several imperfect vertebræ.

In regarding them in the first point of view, the body of the sphenoid portion corresponds to that of the vertebra. Its two wings and the frontal bone represents its lateral portion. Most of the frontal bone and the large wing of the sphenoid bone are in fact analogous to the posterior and superior part of the semi-arches, as the malar process of the frontal bone and the inferior pterygoid process correspond to the articular and the transverse processes of the vertebræ. We must consider the frontal bone as belonging to the anterior vertebra of the skull, because the lateral parts of the sphenoid portion alone do not curve to meet one another, and do not unite with the body to form a ring inclosing the anterior part of the brain, while this ring is produced by the assistance of the frontal bone.

The very complicated ossification of this vertebra occurs according to the same laws as that of the vertebræ of the trunk. Those pieces which correspond to the lateral parts ossify long before the body of the sphenoid portion; and it is a normal condition, that the two lateral halves of the largest portion of the arch of the frontal bone unite in the same manner as the semi-arches of the vertebræ. If the lower part of these lateral pieces unites earlier with the body of the sphenoid portion, thus differing from what occurs in the vertebræ, this difference is made up by another circumstance, viz. that the body

of the sphenoid portion does not completely develop itself, or does not acquire its sinuses, until the pieces of the frontal bone are fused.

Several smaller vertebræ may be demonstrated in this large anterior vertebra of the skull. In fact, we can imagine the sphenoid portion formed of two vertebræ; a posterior, which is larger, and represented by the body and the large wings, and an anterior, which is smaller, and formed by the small wings; and we can suppose the frontal bone either as a portion of this anterior vertebra, which would then be much larger than the posterior, or as the arch of a vertebra of which the body is not developed, since the arches of the true vertebræ are always formed before their bodies.

The central vertebra of the skull is formed by the temporal and the parietal bones. The temporal bones represent a vertebra divided at its lower portion into two parts by the basilar bone. The parietal bones and the squamous portion with the zygomatic and the mastoid processes of the temporal bone, represent the semi-arches and processes; while the petrous portion of the temporal bone corresponds to the body of the vertebra. But we may also, as in the anterior vertebra of the skull, consider the parietal bone only as the rudiment of a particular vertebra, and regard the temporal bones as two halves of vertebræ, entirely distinct from each other.

Here also the parts of the arches are developed sooner than that of the body, and it is remarkable that of all the sutures, the sagittal suture is most frequently and the soonest effaced; so that the semi-arches unite on the median line before they blend with the other portions.

The ethmoid bone differs so strikingly from all the other bones of the skull, that at first view we cannot perceive the least relation between them. We may, however, represent it as a fourth anterior and inferior vertebra of the skull, which, pressed in between the others, would not be developed in a ring, and would be flattened from one side to the other. We may, however, consider its perpendicular plate as the body, and its lateral portions as the semi-arches.

Here as in the rest, the lateral portions osssify before the central part.

§ 647. In the bones of the face, the analogy with the vertebræ is less easily demonstrated. One great point of resemblance is here deficient, viz., the relation with the central part of the nervous system. We may, however, consider, in some measure, the upper maxillary bone as a large facial vertebra, of which the other bones of the face are a compliment. We may also compare the lower maxillary bone with the upper part of the sternum and the upper ribs, and the styloid processes and the hyoid apparatus with the lower part of the sternum and the lower ribs; for their semicircular form, their convexity forward, their concavity backward, their moveable articulation with the skull, and their situation before it, establish a general correspondence with the sternum and with the ribs, in regard to form and connections; and more so, because the upper ribs are united with the upper part of the sternum more intimately than the lower ribs are with the lower part of this bone; precisely the same as the lower maxillary

bone constitutes a single bone, while the hyoid bones and the styloid processes always form several distinct pieces.

We may also add, in favour of this analogy, that as the lower maxillary bone and the ribs are among the bones which are developed the first, and as the ribs form long before the sternum, so, too, the lower maxillary bone generally corresponds to the ribs fused together, and is composed only of two halves, the intermediate cartilage being gradually effaced. When two special nuclei are formed in this cartilage, as sometimes (but rarely) happens, the analogy is still greater; since these nuclei, which correspond to the pieces of the sternum, arise long after the lateral portions.*

§ 648. Finally, we may compare the whole bony head to a large vertebra, composed of several, which are smaller and immoveably articulated with each other, and accompanied by some rudiments of ribs fused together. This method of considering it is much more admissible, because the bones of the skull and some of those of the face tend to unite in a single piece; and even in young subjects, we not unfrequently find all the sutures effaced, and then the head is composed of three bones only, which move on one another,—the lower maxillary bone and the hyoid bones anteriorly, and the collection of the bones of the skull and face posteriorly.

§ 649. The differences of the head a tdifferent periods of life are very great.†

They rgeard principally 1st, *form;* 2d, *mass;* 3d, *number;* 4th, *the mode of union of the bones;* 5th, *the form of the whole;* 6th, *the proportion between the skull and the face.*

1st. The *form*. The bones of the head are much less rough and uneven, and their eminences project less, the younger the organism is. But those of the skull, or at least the occipital bone, the parietal bone, and the frontal bone, differ at different periods of life, inasmuch as from the fourth month of pregnancy to the end of the first year of existence, they are much less uniformly bulging than at anterior and subsequent periods; but they project considerably at their central part, where the point of ossification develops itself; so that the upper and lower portions there unite at an almost right angle. Before the fourth month, the bones of the skull are much flatter than in the restof life, and more so as they are smaller.

2d. The *mass*. The bones of the head increase in extent, thickness and weight, from the commencement till the termination of their development in the adult age; but after this time, and till old age, they always diminish in these three relations. Hence, in advanced life they are thinner, often perforated in several parts, especially where they are

* It seems less proper to compare the jaws to limbs, and the hyoid bones to the pelvis, as Oken has done; although it is not difficult to trace the cavity of the chest in the nasal fossæ, and that of the abdomen in the oral cavity. It is perhaps from the considerable development of the cephalic vertebræ and brain, that the other bones of the head can become only the rudiments of the ribs and sternum fused together.

† *Recherches sur le crâne humain*, by Tenon; in *Mém. de l'Instit. sc. phys. et math.*, vol. i. p 221-233.—Spix, *Cephalogenesis*, Munich, 1815.

naturally thin, as the external and anterior part of the large wing of the sphenoid bone, and the orbital portion of the malar bone: from this cause, the malar bone is frequently separated from the sphenoid bone in this place; the sphenoidal fissure is often very extensive; the maxillary bones are narrower by the entire height of the alveolar edges; and finally, the skull becomes lighter and smaller.

The difference of weight between the skulls of old men and those in mature age is much greater than that of volume. The skull of a female seventy years old, now before us, weighs fourteen ounces, and that of a girl twenty years of age weighs twenty-four ounces; the first is nearly one half lighter than the second.

3d. The *number* of the bones of the head differs at different periods of life. At first the number is smaller, because ossification does not commence in all parts at the same time. Next, the bones are more numerous, because some bones are developed by several points of ossification, whence result separate pieces, which gradually unite.

4th. The *connection* of the bones of the head is much looser the younger the subject is; because the bony pieces are less extensive and are separated by larger intermediate cartilages. In very old persons, the bones which are united, during the greater part of life, by a simple immoveable cartilaginous substance, almost always fuse together. This is the case particularly with the parietal bones which unite with each other, or with the frontal and the occipital bones, and it is true also of the ethmoid bone which joins with the inferior turbinated bone, while the latter is fused with the upper maxillary bone.

5th. In the early periods of life, the *whole form* of the head is much rounder than at an advanced age, which is particularly owing to the small development of the face which the skull overreaches in every direction, and which is proportionally much smaller the younger the fœtus is. In fact, the difference between the greatest length and breadth of the head is much greater the younger the fœtus is, but it bulges more in all parts of its circumference, which makes its general form more round. We remark especially, during the early periods of uterine existence, that the skull is much broader and less compact in the region of the temples than it is afterward, and that the frontal bone, the parietal bone, and the occipital bone, are much more bulging. In a later period the bones sink remarkably.

The more rounded form of the skull during the early periods of pregnancy also results from the slight development of its base. In fact, this is shorter and narrower, and forms with the lateral and posterior faces a more obtuse angle.

§ 650. The form of the bones of the head, and consequently of the whole bony cavity, varies very considerably in the different races.* The differences in this point of view are more or less evident in all directions and in all regions. Hence the facial angle of Camper (§ 51)

* Blumenbach, *Decades collectionis suæ craniorum diversarum gentium illustratæ*, Gottingen, 1790-1814.

will not measure them exactly, since it indicates only the direction of the anterior part of the skull and race, and gives only a general idea of the profile. We must then, at the same time, employ other means to determine it. Thus, on the one hand, we practice the method recommended by Blumenbach,* that is, we embrace as much as possible all the peculiarities with a single glance, looking from behind forward, while the head rests on the lower maxillary bone, so that the malar bones may be horizontal; 2d, we follow Cuvier's method, which consists in looking at the head from above downward and from before backward, to judge of the relations of capacity between the skull and the face.

We have already mentioned (§ 34) the results of these measuremets, which furnish the principal distinctive characteristics of the human races.

The difference between the skull and the face in the relation of their respective capacities, is most important. The difference is most favourable to the skull in the European race; and most unfavourable to it in the Ethiopian. Thus, the skull of a negro, compared with thirty-six skulls of Europeans, contained less water than any of them.†

Besides these differences of races, there are others which establish a difference more or less remarkable in the skulls of different people belonging to the same race.

The nations of the south, in whom we see the purity of the Caucasian race, or those which are most allied to it, as the Greeks and Turks, differ from all other nations belonging to this race by their very round heads.‡

CHAPTER IV.

I. GENERAL REMARKS ON THE ANOMALIES OF THE BONES OF THE HEAD.

1. OF THE CONGENITAL DEVIATIONS OF FORMATION.

§ 651. The congenital deviations in the formations of the bones of the head, affect their *number*, *form*, *connection*, and *size*, and are for the most part more or less dependent on their mode of development. These four conditions are almost always united. We can, however, refer to one or another of them, only the essence of every deviation of formation of a bone of the head, since the number of these last never increases, like those of the trunk and extremities, by the formation of new pieces, but by the division of the primitive bones into several, so that we remark proportional differences in the form, connections, and size of the bones, the division of which has increased the whole number.

* *De variet. gen. hum. nat.*, Gottingen, 1794, p. 203.
† Saumarez, *Principles of Physiology*, London, 1798, p. 163.
‡ For other differences which are less constant, see the work by Blumenbach already cited, and Sœmmering's Osteology.

I. ABSENCE AND SMALLNESS.

§ 652. The bones of the head are entirely deficient in *acephalia vera*. In those cases of acephalia which are somewhat more perfectly developed, we rarely find a slight rudiment of a head composed of several bones.*

After this state, comes, as regards its external form, the *acephalia falsa*, in which the base of the skull and the face are generally regularly developed; but in which also the bones, or the portions of the bones which form the vault of the skull, are entirely deficient, or are very small.

Next comes that state of the bones of the skull which exists in *encephalocele*, when several of these bones, or one only, (generally the occipital bone,) is but slightly developed; and a portion of the brain, or serum collected between it and its envelops, projects through the opening.

Next follows the arrangement of the bones of the skull in *hydrocephalus*, where they are more or less distant from one another, and are often separated by unossified spaces.

The next state is the permanence of the *fontanelles*, which sometimes remain, in one or several parts, during life.

The state which is the least abnormal, although usually attended with some degree of imperfection in the intellectual faculties, on account of the corresponding state of the brain, is the smallness of the head, characterized by the flatness of the anterior portion of the skull, and by its narrowness in the transverse direction: this is principally seen in idiots.†

II. SEPARATION OF THE BONES OF THE HEAD.

§ 653. The best name for the abnormal bones, resulting from this division is, that of *bones of the sutures* (*ossa suturarum*).‡ This in fact is the only general character we can assign to them, since they are not developed, except at the circumference of the concave bones; and never, or at least but very rarely, within them. When the latter is the case, the abnormal bones form only between those parts of bone which are transiently separated, as between the different pieces of the occipital bone; and usually unite when the development is finished. The terms *triangular bones* (*ossa triquetra*) and *wormian bones* § (*ossa*

* Curtius, *De monstro humano*, Leyden, 1762.—Meckel, *Handbuch der pathologischen Anatomie*, vol. i. p. 151.

† Greding, in Ludwig, *Adv. med. pract.*, vol. ii. and iii.

‡ Bertin, *Traité d'ostéologie*, vol. ii. p. 470.—Rose, *De suturis cranii*, Leipsic, 1763.—Monro, *A skull uncommon for the number and size of the ossa triquetra*, in the *Edin. med. essays*, vol. v. no. 16.—Van Doeveren, *Spec. obs. acad.*, ch. viii.—Sandifort, *De ossiculis suturarum*, in *Obs. anat. path.* book iii. chap. ix. and book iv. chap. x. p. 136-141.

§ These bones have been called also *intercalia* or *epactalia*. One of them occurs frequently in the posterior fontanelle; it is the proper epactal bone, the *triangular bone* of Blake, the *os epactale*, s. *goethianum* of Fischer. (G. Fischer, *Observata quædam de os epactali seu Goethiano palmigradorum*, Moscow, 1811.—*Meckel.*

wormiana), are less suitable when considered generally. The first term, however, is not perfectly appropriate, as the division of the frontal bone into two lateral portions also enters into this anomaly, although the relations of this bone with those around it are not changed.

These bones are remarkable in several respects. In fact, 1st, their formation is governed by very precise laws; 2d, they depend, in great part, on the normal development of the bones; 3d, for the most part they establish striking analogies with animals.

1st. These bones are formed according to constant laws. The following circumstances prove it:

a. They are usually arranged more or less symmetrically, so that we rarely find them on one side of the body only; and when unmated, they usually extend as much on one side as on the other.

b. They occur more particularly in the cranium, and much more rarely in the face.

c. They are not equally common in all parts of the skull. They are observed most frequently between the occipital bone on one side, and the parietal and the temporal bones on the other. They are most generally situated in the lambdoid suture, more rarely in the mastoid suture. The parts in which they are next most frequent, are the squamous suture, especially at its anterior extremity, between the large wing of the sphenoid bone, the squamous portion of the temporal bone, and the frontal and the parietal bones. They are more rare in the sagittal suture, where they are seen principally between the two parietal and the frontal bones, consequently at the anterior extremity of this suture. They are least common between the sphenoid bone and the adjacent bones.

In the face, the bones of the sutures are met with principally between the os planum of the ethmoid bone and the frontal, the unguiform and the upper maxillary bones, and also between the latter and the unguiform bones. They are more rare between the two upper maxillary bones. It is equally unusual to find the lower maxillary bone or the malar bones composed of two parts.

d. We may state as a general rule, that they are developed most frequently in the places where large cavities are to be filled. They are very frequent in the fontanelles, and are most common in the posterior, and next in the anterior lateral, middle lateral and the posterior lateral fontanelles.

e. They vary much in size. Sometimes they are only small pieces of bone, and sometimes the whole bone is divided into two equal parts. Thus, the occipital bone is sometimes divided into an upper and a lower portion, and the frontal bone is formed of two lateral portions of equal size. There are numerous degrees intermediate between these two extremes.

anatomica, Moscow, 1819. Another, almost as common, is situated in the temporal fossa. Beclard proposes to call it the *crotophal* bone. The others occupy the occipito- parietal suture, the place of the posterior and inferior fontanelle and the parietal suture. F. T.

f. The cause of the abnormal want of union between the parts of bone, is not always manifest. Although the anomaly is usually attended with an accumulation of serum within the skull (*hydrocephalus*), and with the distention of the ossifying surfaces; we cannot, however, say it is owing to this distention, and suppose, with Blumenbach* that the fœtus has been affected with hydrocephalus, which has been cured.

2nd. The formation of these pieces of bone depends, in great part, on the normal development of the bones of the head. In fact—

a. The separation of the frontal bone into two portions is normal from the origin of this bone till the first year of life.

b. The occipital portion of the basilar bone forms gradually by the union of eleven pieces (§ 543), and these are the pieces which are abnormally separated.

c. The temporal bone is also formed by four nuclei (§ 554); and these are the nuclei which remain more or less sensibly distinct.

d. The small bones of the sutures are most usually formed by the natural development of the bones of the head, since new nuclei always form on the circumference of the primitive germs of bone, which are smaller and more distinct, and which unite with them in one mass when the development proceeds regularly.

All the bones of the sutures however, do not depend upon the abnormal division of the separate pieces of bone, which form only one piece in the normal state; and we cannot consider them all as resulting from an imperfect development. In fact, those in the large and the anterior lateral fontanelles, and in the squamous suture, and also the division of the squamous portion of the temporal bone and of the frontal bone into two parts situated one above the other, are not normal, but are distinct and special formations.

3rd. It is generally very easy to trace the analogy between these abnormal bones and the structure of animals.

a. In most animals the frontal bone is composed of two lateral halves.

b. The separation of the occipital bone in different osseous pieces is also an arrangement which remains in many animals during life, and in others until birth. In many reptiles this bone is divided during life into a basilar, an articular, and a squamous portion, and this last itself into an upper and a lower portion. It is true that the first three parts and the squamous portion unite in a single piece in the mammalia; but in many animals, as also in the fishes, the squamous portion is divided into two parts.

c. The mastoid portion of the temporal bone forms a distinct bone in the mole.

d. The primitive arrangement, that is, the insulation of the different nuclei of bone, remains during life in the gecko.†

* Knochenlehre, p. 180.

† Carus, *Anatomie und Physiologie des Nervensystems*, Leipsic, 1821.

However, the other bones of the sutures, which constitute positive anomalies, do not appear in animals.

From what precedes, it follows that our views upon the origin of these bones are more extensive than certain anatomists have thought,* since we can say, that most of them are produced by a development deficient in energy.

§ 654. The development of these bones forms an unusual number of sutures, since its essence consists in increasing the number of pieces of bone at the expense of the normal bones.

The slightest deviation from the normal state is the existence of a suture called the *frontal suture* (*sutura frontalis*) between the disunited portions of the frontal bone, which sometimes extends through the whole bone, and sometimes exists only at its upper or lower part, more frequently in the former. As this suture is continuous with the sagittal suture, and cuts the coronal suture at a right angle, those heads which have them are termed *capita cruciata*. The other supernumerary sutures arising from the same source are usually small and imperfect, and do not extend the whole breadth or height of the bone. Sometimes, however, we find the occipital bone and more rarely the parietal bone entirely divided by a transverse suture into an upper and a lower half.

We must remark, in regard to this, that the division is most frequent in the frontal bone ; it is more rare in the squamous portion of the occipital bone, and still less frequent in the parietal bones ; so that its degree of frequency is in direct ratio with the time during which the bone remains in its primitive form, or, more particularly, with the occurrence of deviations of formation in the primitive pieces.

If the number and situation of the bones of the sutures be such as to form along one of the usual sutures a chain corresponding to the normal form of the corresponding edges of the bones, which are wedged in between them, we then have *double sutures* (*suturæ duplices*), which are generally seen between several bones of the same skull, since these bones are usually developed in several regions of the skull in the same subject, but not in the same number.

The unusual distance between the bones of the skull, which is caused by hydrocephalus, is allied to the abnormal development of separate bones formed at the expense of the normal bones. Then we have developed not only a greater or less number of bones of the sutures, but these are also separated by large unossified spaces.

Finally, we must arrange here the want of union between the palate-bone and upper maxillary bone on the median line, which essentially constitutes *hare-lip*. Another anomaly allied to this, and dependent on the same proximate cause, is the imperfect ossification of the skull-bones, which present from space to space hollows filled with cartilaginous substance only. This anomaly is also seen in hydrocephalus, and is sometimes primitive and sometimes consecutive.

* Hildebrandt, *Lehrbuch der Anatomie*, vol. i. p. 216.

III. OF THE ABNORMAL UNION OF THE BONES OF THE HEAD.

§ 655. The state opposite to that which we have examined supervenes usually at an advanced age ; but it is not rare in young people, and is frequently seen in hydrocephalus, in consequence of the disappearance of the cartilaginous layer interposed between the adjacent bones.

These anomalies are also subject to certain laws :—

a. The pieces of bone which remain separate and distinct beyond the proper periods usually fuse with the adjacent bones sooner than these unite with one another.

b. Of all the bones of the skull, the parietal bones unite soonest and most frequently : their union commences generally, but not always, in the centre of the sagittal suture. The temporal bones and the occipital bone unite less frequently, and the frontal bone still less so ; in regard to which we must observe that the central portion of the coronal suture is usually the first to disappear. The union of the frontal and the temporal bones, of these latter with the sphenoid bone, and of the ethmoid bone with the adjoining bones, is more rare.

In the face, the inferior and the middle turbinated bones fuse with the upper maxillary bone, the vomer unites with the sphenoid bone, and the two nasal bones with each other.

§ 656. The bones of the skull sometimes become unusually large. This state generally attends hydrocephalus, and the anomaly becomes very striking when we regard the base of the skull at the same time, since we there see more or less sensible marks of the compression caused by a mechanical power acting from within outward.

§ 657. The bones of the skull vary also in thickness. In advanced age they are thinner than during the early periods of life. The same thing is seen in hydrocephalus. However, at the end of life they become thicker, but also very spungy. They are also thicker in idiots ;* although then the relation of causality between this state of the skull and that of the brain probably is not always the same, since the excessive development of the bones from within may be a primitive anomaly, and cause a compression of the brain which is injurious, or their unusual increase may depend upon a want of nutrition and on the shrinking of the brain. Besides, the thickening of the bones of the skull is attended sometimes with an increase and sometimes with a diminution in the density of their tissue.

§ 658. The bones of the skull are sometimes abnormal by a defect in symmetry, so that they, and consequently the whole head, appear *oblique*. This state depends perhaps upon a primitive congestion of serum in the skull, and upon the unequal pressure exercised by the fluid. It sometimes attends mental derangement.

* Greding, in Ludwig, *Adv. med. pract.*, vol. ii. p. 456, vol. iii. p. 600.

The bones of the skull present other anomalies, especially in *cretinism.** Although the form of the head in cretins is not always exactly the same, the skull however is generally low, less bulging particularly in the frontal and the occipital regions, and on the contrary unusually broad from side to side; the base from before backward is short and somewhat compressed; the sutures are more or less completely effaced, and filled with numerous *bones of the sutures.* In regard to particular bones, the basilar bone differs most from the normal state: it is small, flat and even concave at its upper part, while its articular parts and the occipital foramen are more or less oblique and sometimes almost perpendicular, so that the articular portions look directly forward, and the basilar process and the body of the sphenoid bone are straight and very elevated.

It often happens also that the skull is more or less oblique, especially in the moderate degrees of cretinism, which obliquity seems to depend upon the existence of the anomalies on one side only.

§ 659. The consecutive or accidental deviations of formation in the bones of the head are—

1st. The *solutions of continuity.* Sometimes these are *fissures* (*fissuræ*), which are often extremely small, and are then termed *capillary openings.* They differ from the normal or abnormal sutures in being straighter, in the periosteum not adhering with as much force as usual, in not having cartilage upon their edges, and in being seen in the places upon which the wounding cause has acted. We call these *counter-fissures* (*contra-fissuræ*) when they supervene on the side opposite to that on which the blow has been struck. Both extend from one bone to another, passing over the sutures. Sometimes there are *depressions* (*depressiones*), when there is no solution of continuity, but a piece, wholly or partly detached, is pressed in. Depressions can take place without a fracture in youth, because of the thinness and the elasticity of the bones of the head.

2d. The separation of the connections of the bone (*diastasis*), which, if the sutures are perfectly developed, can be caused only by a very violent mechanical action.

SECTION III.

OF THE BONES OF THE EXTREMITIES.

§ 660. The bones of the upper and lower extremities correspond not only on the right and left sides, but also upward and downward; so that the lower limbs are a repetition of the upper, in respect to number

* J. F. Ackermann, *Ueber die Kretinen, eine besondere Menschenabart in den Alpen*, Gotha, 1790.—Foderé, *Essai sur le goitre et le crétinage*, Turin, 1792.—Michaelis, *Ueber die Kretinen im Salzburgischen*, in Blumenbach, *Med. Bibl.*, vol. iii. p. 658.—Joseph and Charles Wenzel, *Ueber den Kretinismus*, Vienna, 1802.—H. Reeve, *Some account of cretinism*, in the *Edin. med. journ.*, vol. v. 1809, p. 31–36. Iphofen, *Der Cretinismus, philosophisch und medicinisch untersucht*, Dresden, 1817.

and form, and the mutual relations of the different sections of which each limb is composed.

§ 661. Each is composed of four grand sections: the first is formed principally by one large bone; this is the *scapular portion* (*Portio scapularis*) in the upper limb, and the *iliac portion* (*P. iliaca*) in the lower; the second includes one cylindrical bone, the *humerus* in the upper extremity and the *femur* in the lower; in both, the longest and the next section is composed essentially of two bones, which are the *radius* and the *ulna* in the fore-arm, and the *tibia* and the *fibula* in the leg; the fourth comprises, in the upper extremity, the bones of the hand, and below, those of the foot, which correspond with each other almost perfectly in number, form, and divisions.

CHAPTER I.

OF THE BONES OF THE UPPER EXTREMITIES.

ARTICLE FIRST.

OF THE BONES OF THE SHOULDER.

§ 662. We find on each side two bones in the region of the shoulder: the larger is flat, situated backward and a little on the side; the smaller is cylindrical and is situated at the anterior and superior part of the shoulder: the former is termed *scapula*, the latter the *clavicle*.

I. OF THE SCAPULA.

§ 663. The *scapula* (*omoplata*) has in general the form of an equilateral triangle, the base of which looks upward, and it extends, when all the muscles which unite the bones of the trunk and those of the superior extremities are inactive, from the second to about the seventh rib, and its internal edge is nearly an inch distant from the lateral portion of the spinal column.

§ 664. It has three edges; the internal is longer than the external, and hence is called the *base* (*basis scapulæ*). In its upper fourth, its direction is from above downward and from without inward, and it is more or less convex. After leaving this point, it proceeds almost directly downward and outward, and is parallel to the external. The latter, which unites to it at an acute angle, is most prominent at its lower part, where it is straight and very thin, while it is slightly concave and much thicker at its upper portion; so that the anterior and posterior faces of the scapula, particularly the latter, pass much beyond it. The upper extremity of this edge enlarges still more, to form a superficial oblong cavity, which is narrower upward, and is called the *glenoid cavity* (*cavitas glenoidea*), and which projects very far outward.

The upper edge is oblique from within outward and from above downward, and it is slightly concave at its upper part. Toward its internal extremity, we see a semicircular groove (*incisura semilunaris, lunula*), which is more or less distinct, but always distinguished from the rest of the concavity by a greater depth. This fissure is sometimes changed into a foramen by a slip of bone.

Where the superior and external edges unite, the scapula extends into a process curved upward and forward, the *coracoid process* (*processus coracoideus*). The upper face of this process is turned inward and its lower face outward.

§ 665. The posterior and external face of the scapula is divided into two portions by an eminence which extends obliquely from the internal to the external edge, and is called the *spine of the scapula* (*spina scapulæ*); the upper is smaller, and is termed the *fossa supra-spinata;* the inferior portion is much larger, and is termed the *fossa infra-spinata.* The whole external face of the scapula is a little convex backward, particularly in the *fossa supra-spinata.* The spine itself begins near the internal edge, by a small, triangular, broad elevation, which inclines downward very much, and gradually enlarges from within outward. It does not go directly backward, but is inclined at the same time from below upward and from before backward, so that it makes an acute angle with the supra-spinal portion, and an obtuse angle with the infra-spinal portion.

It does not extend as far as the external edge, but stops at some distance from the posterior edge of the articular surface; so that an interval exists between this and the last, which is the *neck of the scapula* (*collum scapulæ*). The direction of the spine now changes, and it enlarges very much from without inward. This part, which is found about an inch distant from the glenoid cavity, and which projects upward and inward, is called the *acromion* process; it is the highest point of the scapula. It confines the motions of the head of the humerus inward and upward, as the coracoid process limits them forward and upward. Its posterior edge presents, immediately behind this upper extremity, a small straight surface which is covered with cartilage.

§ 666. The anterior face is more uniform. It presents only a slight depression, which corresponds to the spine; and we can distinguish on it also a supra-spinal and an infra-spinal portion. This latter usually presents three small ridges, which ascend upward and outward from the base, and which unite nearly in the centre, and between which are superficial depressions. All the anterior face is slightly concave.

§ 667. The infra-spinal portion of the scapula is the thinnest. The bone becomes thicker toward its edges, but principally toward the internal, and on the side of the articular eminence. It is a little thinner in the coracoid process, and still more so in the spine, although this is thicker than the fossæ.

§ 668. The scapula first appears toward the end of the second month of pregnancy, as a flat and irregularly quadrilateral bone, on the surface of which the spine is not yet visible; this is developed at the

third month of pregnancy, and extends from its origin beyond the upper edge.

In the full grown fœtus the processes appear, but are still almost entirely cartilaginous. The spine never develops itself by a single point of ossification, but appears as a prolongation backward of the posterior face. Gradually, however, we see a distinct germ of bone for the coracoid process, which exists even in the full grown fœtus, or at least appears in the first year. It is, however, usually united with the rest of the scapula in subjects fifteen years old. At the point of union, and about the period when it is finished, there is developed, above and at the base of the coracoid process, a rounded nucleus of bone, which remains separate and distinct longer than the other processes. Afterward, when the coracoid process is united, we see also special nuclei of bone for the upper part of the acromion process, for the lower angle, and for the base: these do not unite to the principal portion until the growth of the subject is matured. The size of the osseous nucleus of the acromion process varies much; for sometimes it is only a narrow band, and sometimes forms most of this process.

§ 669. The deviations of formation in the scapula are particularly its continuance in an early stage of development. Thus, sometimes the portion of the acromion process remains separated during life, being united to the rest of the bone only by cartilage.

Sometimes the process of ossification is not perfect in other points, so that a greater or less portion of the *fossa infra-spinata* remains cartilaginous, which is singularly analogous with what is observed in many mammalia, especially the *pachydermata*.

II. OF THE CLAVICLE.

§ 670. The *clavicle* (*clavicula, clavis, os juguli, furcula, ligula*) is situated on the line of separation between the neck and the chest, between the sternum and the scapula. It extends a little obliquely from before backward, from below upward, and from within outward. It is turned like an italic *S*, so that the outer half is convex backward and concave forward, while the inner half is concave backward and convex forward.

We distinguish in this bone a *body*, a *sternal extremity*, and a *scapular extremity*.

The *body* is contracted from above downward. It, however, presents more or less distinctly three faces: a posterior, smooth and concave from above downward; an upper, oblique from above downward, and from behind forward, and very rough; finally, a lower, straight or slightly concave, smooth or slightly rough. Among the angles, the upper, which forms at the same time the upper edge, is the only one which is seen distinctly. It is also rounded. We usually find one and sometimes two foramina of nutrition on its posterior face.

The *anterior* or *sternal portion* (*pars sternalis*) is the thickest, and most evidently triangular portion of the clavicle; it terminates by

a mostly triangular, cartilaginous, but uneven surface, the base of which looks upward, and sometimes has a more irregular and rounded form. At the beginning of this sternal portion, we often find on its anterior face a considerable and rough depression, and further outward a rough elevation.

The *posterior* or *scapular portion* (*pars scapularis*) is the broadest portion of the bone, and the flattest from above downward: on its upper face are muscular impressions; on the lower are asperites, to which the ligaments are attached: and at its external extremity is a larger or smaller cartilaginous articular surface.

§ 671. The clavicle is very remarkable in the history of the development of the organism, because it is one of those parts most proper to demonstrate the great difference which is presented in the form, and particularly in the proportional volume of one and the same organ at different periods of life. Notwithstanding its smallness, it appears very early, if it is not the first of the bones which develops itself. Towards the middle of the second month of pregnancy, its length is about three lines, and it is four times as large as the humerus and the femur. At the third month of fœtal existence, it is nearly twice as long as these bones; and at the end of the month it continues larger than them. The humerus is larger in the fourth month; in the full-grown fœtus it is only one-fourth longer, while it is twice as long in the adult. The division of the clavicle into a body, a sternal and a scapular extremity, is founded solely on the different dimensions of these regions, and on their relations with the adjacent parts, but not on their mode of development: for the clavicle arises by a single point of ossification, excepting always a very thin nucleus of bone, which forms very late on the anterior face of its sternal extremity.

§ 672. This bone is also one of those in which the sexual differences of the skeleton are most manifest. It is generally straighter, and proportionally smaller in the female than in the male. Its greater straightness depends particularly on the lesser curve of its external portion, while in man it extends far backward and then comes forward. The internal anterior half presents nearly the same curve in both sexes. The clavicle of the female is rounder than that of the male: we, however, find clavicles of females perfectly like those of males, and vice versa. Sometimes of the two clavicles in the same body, one is constructed in the type of the male; and the other in that of the female. These two anomalies are a slight degree of hermaphrodism.

§ 673. The clavicle is articulated by its anterior extremity with the handle of the sternum, by its posterior extremity with the acromion process of the scapula, and also with the scapula and with the first rib by fibrous ligaments.

§ 674. Sometimes a portion of the clavicle, particularly the external, is deficient, even when the upper extremity is otherwise normally developed; and it is then replaced by a process of the scapula, which however is always thinner.*

* Martin, *Déplacement naturel de la clavicule:* in *Roux, Journal de Méd.*, vol. xxiii. p. 458.

ARTICLE SECOND.

OF THE HUMERUS.

A. NORMAL STATE.

§ 675. The *arm bone* or the *humerus* (*os humeri, os brachii*), the third in size of the round bones, forms alone the bony foundation of the arm. Its body is slightly twisted; it gradually becomes thinner from above downward, but is broader at its lower extremity. Its three faces are more marked at the lower than at the upper part, which is rounded rather than triangular. These faces are, when the arm is extended along the body, an *anterior*, a *posterior*, and an *external*. The first two are almost straight; the upper part of the posterior face alone is convex, and at its lower part is straight. The internal edge, which terminates the anterior and posterior faces, is very rough in the upper part of the bone where the anterior and posterior edges are hardly perceptible, while they are very distinct in the inferior portion, and become more so when examined still lower. The upper extremity of the body enlarges considerably, particularly inward and backward. The foramen of nutrition, which is single, is found at the commencement of the lower third, on the anterior face near the internal edge, sometimes even on this or on the posterior edge.

It is extended into an upper process, the direction of which varies a little inward and backward from that of the body. Its greater posterior, inner, and upper portion, forms a semi-spherical *head* (*caput humeri*), covered with cartilage, which is surrounded with a slight and somewhat rough depression. On the outer and anterior circuit of this upper process, are two eminences for the insertion of the muscles, the *tuberosities* (*tubercula*) of the humerus, one of which is three times as large as the other, is situated outward and forward and is called the *external, anterior*, or *larger tubercle* (*tuberculum majus, anterius, externum*); while the other, smaller but more projecting, is called the *smaller, posterior*, or *internal tubercle* (*T. minus, posterius, internum*). From each of them proceeds a rough line, of which that of the large tubercle (*spina tuberculi majoris*) terminates in the internal edge, and that of the small tubercle (*spina tuberculi minoris*) is not more than a third or a fourth as long as the body of the humerus, and disappears at this height. A groove, which varies in depth, exists between the tubercles; this goes downward, forward, and outward, and soon disappears on the upper extremity of the internal face of the body; this is the *bicipital groove*.

The lower extremity is more complex than the upper. The bone is here a little broader, but is much thinner than at its upper end; and is consequently flat. It terminates downward by an oblong, round, and cartilaginous projection, the surface of which is very uneven from several eminencies and depressions. Its anterior or external portion

is rounded, and extends much higher on the anterior or internal side of the bone, than on the posterior or external : it is the *inferior head* (*eminentia capitata*). The posterior or internal part is much large extends as high backward as forward, and is composed of two semicircular eminencies, of which the external or anterior, situated at the side of the former, and separated from it by a fissure, is much smaller than the internal or posterior, which is also separated by a considerable depression. These two eminencies form the *pulley* (*trochlea ossis humeri*). We observe over the inferior head a slight depression, called the *small anterior fossa* (*fossa anterior minor*); above the pulley and forward, another deeper depression called the *great anterior fossa* (*fossa anterior major*); finally, backward, and also above the pulley a third depresssion, deeper than the other two, called the *largest* or the *posterior fossa* (*sinus maximus*, s. *fossa posterior*). The last two cavities not unfrequently communicate by a large opening in the bone, which generally exists upon both sides of the body. The bone, too, is sometimes perforated with a large rounded opening over these articular eminencies.

Besides these articular processes in which the lower extremity of the humerus terminates, its anterior and posterior edges present two eminences which are not so deep, but serve as attachments to muscles ; these are the *condyles* (*condyli*). The anterior and outer condyle is much smaller, and is termed also the *epicondyle* (*condylus flexorus*). Most of the flexor muscles of the hand are inserted in it, and also in that part of the anterior face of the humerus over it. The *posterior* and *internal condyle* or *epitrochleus*, (*condylus extensorius*), which is three times as large, gives attachment to the extensor muscles of the hand.

§ 676. The humerus begins to form about the middle of the second month of pregnancy. Toward the end of this month it is still small, only about a line long, and flat. Perhaps it develops itself by two points of ossification, situated one at the side of the other, which grow together rapidly; for in young fœtuses we have seen a fissure extending from its upper extremity to its central portion. Even till the last month of fœtal existence, the body only is ossified; but at this period ossification commences also in the extremities, and first in the inferior.

This presents at birth only one nucleus of bone, which is not situated in its centre, but in the small head. Sometimes, and most generally the body gradually extends into the pulley, or a single nucleus of bone is developed in the pulley, which fuses first with the head, then with the body. Some months after birth we see an osseous germ in the upper extremity or in the place of the head, with which a second, in the large tubercle, unites afterward, and usually at the end of the first year: these two nuclei fuse together before the whole extremity joins the body. Still later, the internal or posterior condyle develops itself by one point of ossification, which fuses sometimes with the body and sometimes also with the rest of the inferior extremity. This last unites with the body sooner, long before the subject is perfectly grown, while the upper remains distinct and separate until after this period. The

internal tubercle fuses with the body much sooner than the upper, but much later than the lower.*

§ 677. The humerus forms, by its head, with the glenoid cavity of the scapula, an arthrodia: its lower extremity is united with the two bones of the fore-arm.

B. ABNORMAL STATE.

§ 678. The humerus is sometimes entirely deficient, from a primitive deviation of formation, or in a greater or less portion when the upper limbs are more or less imperfectly developed. The degrees of this anomaly are very various; for sometimes a very small stump only appears; sometimes, when the development is more advanced and the fore-arm and hand only are deficient, the humerus becomes thin at its lower extremity, and terminates in one or two processes.†

We have already mentioned (§ 673) the union of the larger anterior and posterior fossæ.

ARTICLE THIRD.

OF THE BONES OF THE FORE-ARM.

A. NORMAL STATE.

§ 679. The bones of the *fore-arm* are two, the *radius* and the *cubitus* or *ulna*, which are nearly equal in size, are situated on the same plane, and are both articulated with the humerus; but which are capable of executing very different motions, on account of the forms of their articular surfaces.

I. OF THE ULNA.

§ 680. The *ulna* (*ulna* s. *cubitus*, *canna major*, *focile majus*) is longer than the radius, and this extra length extends above it. It deserves then to be examined first, partly on this account and partly because being less moveable, it forms the basis of the bony frame of the fore-arm.

Its body gradually diminishes in thickness from above downward, and it is slightly curved in the form of an S; for near the centre it approaches the radius, then separates from it, and again approaches it at its lower extremity. Its upper portion, which is the longest, presents very distinctly three faces: these are, when the fore-arm is at rest, a posterior, an anterior, and an internal face; but they disappear at its lower portion, where the bone becomes rounder. The posterior and the anterior faces are almost straight: sometimes, however, the anterior is

* Albinus has pointed out, but very imperfectly, the order in which the nuclei of ossification are developed and united.

† Bonn, *Thes. ors. morb. Hov.*, Amstelodam, 1783, p. 120.

divided by a longitudinal eminence into two broad furrows. The internal face is always slightly grooved, The anterior edge, which limits the external and the anterior faces, and which looks toward the radius, projects the most and is called the *crest of the ulna* (*crista ulnæ*). At the upper extremity of the anterior face is a large eminence, which gives attachment to certain muscles, and is called the *tubercle*, or *head of the ulna* (*tuber ulnæ*).

The foramen of nutrition is usually situated a little above the centre of the bone, at the side of the crest, on the anterior or on the internal face. The upper extremity has the form of a hook, is the largest part of the bone, and is much thicker than the lower part. The upper and posterior part of this hook, the *olecranon process* (*olecranon, processus anconæus*), is directed perpendicularly from below upward; it is slightly rough, and convex at its upper and posterior part, and its anterior portion is concave and faced with cartilage. Where the upper face is continuous with the lower, is formed the *tuberosity of the olecranon* (*tuber olecranii*). The anterior part of the hook, the *coronoid process* (*processus coronoideus*), has a horizontal direction and is much lower. It presents an upper cartilaginous and concave surface, which is continuous at a right angle with the anterior face of the olecranon process, and is separated from it by a transverse fissure, which backward and inward usually presents no cartilage. These two cartilaginous surfaces form by their union a very deep cavity, called the *large sigmoid cavity* (*cavitas semi-lunaris, sinus sigmoideus, sinus lunatus major*), which is divided in its whole extent by a prominent line into two portions of which the posterior is broader. Next to the anterior horizontal portion of this articular cavity, and joined to it at a right angle, we find, on the anterior face of the upper end of the ulna, the *small semi-lunar cavity* (*cavitas semilunaris, sinus sigmoideus, sinus lunatus minor*), which is much flatter, transverse, and also covered with cartilage.

The lower and rounded extremity of the bone swells out a little, and hence it is called the *head* (*capitulum ulnæ*). Its inner and anterior part is covered with cartilage; the external is extended into a small rounded process, separated from the rest of the surface forward and backward by a groove, which is called the *styloid process* (*processus styloideus*). The inferior face of the head is slightly channelled.

§ 681. The ulna appears as early as the humerus (§ 676), or shortly after it. In the full grown fœtus it is composed of a single nucleus of bone, which comprises all the upper process. Later, and rarely before the sixth year, nuclei of bone are developed above and below it. We first see the nucleus of the lower extremity which forms the base of the head, with the lateral faces and the styloid process. A little later, there are developed in the upper end the three nuclei of the olecranon process. Two of these are situated inward, one at the side of the other, and extend transversely from before backward; the posterior is much larger than the anterior; the third, which is the largest of all, is found externally, and very much resembles the patella, both in situation and in its round form; these three nuclei concur but slightly to form

the upper extremity of the ulna. They are not united with the body even at puberty; the upper unite with it much sooner then the lower, which remains separate until the subject has attained its growth.

§ 682. The ulna articulates at its upper extremity with the posterior part of the articulating surface of the lower end of the humerus, or the pulley, the elevations and depressions of which correspond perfectly to those of the large sigmoid cavity. In a state of extreme flexion, the anterior and most projecting part of the internal edge of the coronoid process engages itself in the larger anterior fossa of the humerus: when the fore-arm is extended, the olecranon process is received into the posterior fossa of this same bone (§ 675). The small lateral fissure of the upper extremity receives the commencement of the head of the radius, the inferior extremity of which turns around the convex and cartilaginous portion of the head of the ulna.

II. OF THE RADIUS.

§ 683. The *radius* (*radius, focile minus*) is much shorter than the ulna, and differs from it in being much thicker in its lower than in its upper part. It occupies the anterior region of the arm when in a state of repose along the body, and the external region when this limb is turned outward. It is considerably curved; for its central part is convex forward and concave backward, while the upper and lower portions are almost straight.

We distinguish in the body three faces and three edges. The internal face is the broadest, slightly concave upward, and convex downward; the foramen of nutrition is situated a little above the centre of the bone. The anterior face is very concave, the external is almost straight. The posterior edge, or the *crest of the radius* (*crista radii*), projects considerably, especially at its central part; the anterior and external edges are very round, so that the inner face is insensibly continuous with the anterior, and this with the external, while there is a well defined limit between the external and internal faces. Near the upper extremity of the bone, we see on the internal face the *tuberosity of the radius* (*tuberositas radii*), a considerable rounded, oblong eminence, which gives attachment to certain muscles, and in which the posterior and the anterior edges unite. Above this point the bone slightly contracts, becomes round, and forms a *neck* (*collum*), which is rather long, and follows a similar direction. The neck enlarges at its upper extremity, and with it is connected the *head* (*caput radii*), which is round, slightly concave below, and covered with cartilage in every part.

The body gradually increases while descending, and finally becomes very thick. It spreads especially from before backward, and supports the lower triangular process, the base of which is turned backward, and the summit forward. The summit projects a little beyond the inferior face, and this forms a small prominence, called the *styloid process* (*processus styloideus*). The lower cartilaginous face is divided, by

a small eminence, the direction of which is from within outward, into a posterior portion, which is square, and an anterior and triangular part. The posterior lateral face is also covered with cartilage, slightly excavated, and forms the *semilunar notch* (*incisura semilunaris*). The anterior is almost straight. The external is convex, and has a large projection in its centre. On both sides of this projection is a considerable tendinous groove, which extends from above downward, and which contains another smaller.

§ 684. The radius appears at the same time as the ulna. It is already developed in the full grown fœtus, but is composed of only one part, the body. At this time its lower part does not much exceed that of the ulna in size, because this last is much thicker proportionally than it is afterwards. The osseous nucleus of the inferior process appears in its anterior portions first, but rarely before the end of the second year. The upper extremity does not begin to develop itself till towards the age of seven years ; it however fuses with the body long before the subject is fully grown, while the lower remains separate even after this period.

§ 685. The radius articulates by the upper face of its head with the small head on the lower articular surface of the humerus ; by the lateral face of this head, which is covered with cartilage, with the small semilunar cavity of the ulna ; by the semilunar notch of its lower extremity with the cartilaginous surface of the head of the ulna ; finally, by its inferior face, forward with the scaphoid bone, and backward with the semilunar bone of the wrist.

§ 686. By the arrangement of the corresponding articular surfaces, the radius posessess the motions of flexion and extension with the ulna, but can also partially turn on its axis, while the ulna changes its position very slightly. It is so connected with the wrist, that the hand follows all its motions. If the radius turns from before backward and inward, crossing the ulna obliquely, the posterior edge being directed outward and the internal face backward, the back of the hand is carried forward and the palm backward, the arm hanging beside the body ; this is called *pronation* (*pronatio*). The opposite motion, which brings the radius and the ulna on the same plane, carries the back of the hand backward and brings the palm forward, is called *supination* (*supinatio*). In both cases the upper and lower extremities of the radius turn on the corresponding lateral faces of the ulna, which are faced with cartilage.

B. ANOMALIES.

§ 687. Sometimes one of the bones of the fore-arm is deficient, sometimes both. In the latter case, the hand is generally deficient ; in the former, the hand is often well formed.

ARTICLE FOURTH.

OF THE BONES OF THE HAND.

A. NORMAL STATE.

§ 688. The hand comprises three regions, the *carpus*, the *metacarpus*, and the *fingers*. That face which looks outward when the arm is hanging down is called the *back* (*dorsum manus*), and the opposite face the *palm* (*palma, vola*): the former is convex, the latter slightly concave. The edge turned forward in the same posture of the arm is called the *radial* edge (*margo radialis*), and the opposite edge is the *ulnar* (*M. cubitalis*). The faces of the different bones of the hand are then distinguished into *dorsal*, *palmar*, *radial*, and *ulnar*.

I. OF THE BONES OF THE WRIST.

§ 689. The *wrist* (*carpus*) is the uppermost and the shortest region. It is composed of eight, sometimes of nine bones, which are very irregular, do not ossify till after birth, are very closely united with each other, and articulate with the bones of the metacarpus. Beside the four regions which it has in common with all the bones of the hand, we distinguish in it a *brachial face* (*facies brachialis*) and a *digital face* (*F. digitalis*). The bones which form it are arranged in two rows, a *posterior* or *upper*, and an *anterior* or *lower*.

1. OF THE BONES OF THE FIRST CARPAL RANGE.

§ 690. The *posterior range of the carpal bones* comprises four, which are, counting from before backward, or from the radial to the ulnar side, the *scaphoid* bone, the *semilunar* bone, the *pyramidal* bone, and the *pisiform* bone.

1. OF THE SCAPHOID BONE.

§ 691. The *scaphoid* bone (*os naviculare*, s. *scaphoideum*) does not perfectly deserve this name, for its form is very irregular. In fact it is boat-shaped in its upper and posterior portion; but forward is a large projection, which makes almost one half of its mass. It is composed of two parts, which are separated by a narrower portion, and it may be compared to the figure 8. Its upper posterior part is broader but flatter than the inferior anterior portion. Its brachial face is convex and covered with cartilage. The digital face is concave and divided by a rounded projection into two semicircular portions, a posterior, smaller and plane, and an anterior, which is larger and very concave. The first may be considered the ulnar face; the second extends to the anterior part. The brachial and palmar faces of this part are not covered

with cartilage, although the radial and digital faces form a triangular surface covered with a cartilage, which is divided by an eminence, the direction of which is from before backward, into two parts, the one longer and triangular, which is found outward, the other smaller, in form an oblong square, and turned downward.

§ 692. Although the scaphoid bone is one of the largest of the carpal bones, it does not begin to ossify till several years after birth.

§ 693. The scaphoid bone articulates, by its upper and cartilaginous face, with the anterior triangular portion of the lower face of the radius (§ 685); by its ulnar face, with the semilunar bone (§ 696), by the posterior digital face, with the os magnum (§ 709); by its radial face, with the trapezium; finally, by the anterior portion of its digital face, with the trapezoides (§ 704).

II. OF THE SEMILUNAR BONE.

§ 694. The *semilunar bone* (*os lunatum* s. *semilunare*) has a convex brachial face, which is covered with cartilage. This face is insensibly continuous with the convex palmar face, which has no cartilage, and with the straight dorsal face. The radial face is semicircular and entirely covered with cartilage. The ulnar face has the same form; it is destitute of cartilage except on its upper, posterior, square portion. These last faces are straight. On the digital face is a deep cavity, which is covered with cartilage.

§ 695. Ossification commences as late as in the scaphoid bone.

§ 696. The semilunar bone articulates, by its brachial face, with the posterior square portion of the lower cartilaginous face of the radius (§ 685); by its radial face, with the scaphoid bone (§ 693); by its ulnar face, with the pyramidal bone (§ 699); and by its digital face, with the os magnum.

III. OF THE PYRAMIDAL BONE.

§ 697. The *pyramidal bone* (*os triquetrum*, *triangulare*, *cuneiforme*) has its base forward and its summit backward. The internal and anterior smaller portion of its brachial face is covered with cartilage in a triangular space; its radial face is straight and plane, and is every where covered with cartilage; most of the digital face is a little concave, and also mostly covered with cartilage; lastly, the palmar face is rough and slightly concave in its inner half; its outer half is straight and covered with cartilage.

§ 698. Its ossification advances equally with that of the two preceding.

§ 699. It articulates by the cartilaginous portion of its brachial face with the triangular intermediate cartilage, by its radial face with the semilunar bone (§ 696), by its digital face with the unciform bone (§ 714), and by the cartilaginous part of the palmar face with the pisiform bone (§ 700).

IV. OF THE PISIFORM BONE.

§ 700. The *pisiform bone* (*os pisiforme, articulare, subrotundum*) is the smallest bone in the wrist. Its form is rounded and oblong, and it is situated entirely above the palmar face of the other bones in the posterior range, which are almost all on the same level except the anterior part of the scaphoid bone, which also projects considerably into the palm of the hand. The dorsal face of this bone is straight and covered with cartilage, and is the articulating surface, uniting it with the pyramidal bone (699). It does not begin to ossify till after the age of six years. It forms with the scaphoid bone (§ 690) the *upper eminences of the carpus.*

II. OF THE BONES OF THE SECOND, THE INFERIOR OR ANTERIOR, CARPAL RANGE.

§ 701. The *second carpal range* includes the largest and most irregular bones of this region. The first three bones of the upper range, however, are larger than the two anterior of the second. The bones of the latter, counting from before backward, are the *trapezium*, the *trapezoides*, the *os magnum*, and the *os unciforme.*

I. OF THE TRAPEZIUM.

§ 702. The *trapezium* (*os multangulum, majus trapezoides, trapezium rhomboides*) has a very irregular quadrilateral form. Its quadrilateral, transverse brachial face is divided by a sharp ridge, which extends from the palm of the hand to the palmar edge, into two slightly concave surfaces, having the form of an irregular square, situated one at the side of the other, and covered with cartilage. The digital edge is transverse, concave from behind forward, slightly convex from the back of the hand to the palm, and also covered with cartilage. The dorsal, palmar, and radial faces are very uneven and rough.

§ 703. This bone is still entirely cartilaginous at the age of six years.

§ 704. It articulates by the anterior part of its brachial face with the scaphoid bone (§ 693), by the posterior with the trapezoides (§ 706), by its ulnar face with the metacarpal bone of the index finger, by the digital face with the metacarpal bone of the thumb.

II. OF THE TRAPEZOIDES.

§ 705. The *trapezoides* (*os multangulum*, s. *trapezium minus*, s. *pyramidale*) represents a short and irregular pyramid, the base of which is toward the back of the hand and the summit toward the palm. The dorsal and palmar faces are rough, destitute of cartilage, and slightly concave.

706. Ossification always begins in it later than in the trapezium.

707. It articulates by its brachial face, which is but slightly concave, with the scaphoid bone (§ 693); by the radial edge which is a little convex, with the trapezium (§ 704); by its digital face, which is triangular, convex from before backward, and concave from above downward, with the metacarpal bone of the index finger, and by its convex ulnar face with the os magnum (§ 710).

III. OF THE OS MAGNUM.

§ 708. The *os magnum* (*os magnum*, s. *capitatum*) is the largest of the carpal bones. Its form is pyramidal, and it is so situated that its greatest diameter extends from its brachial to its digital face, the latter representing its base and the former its summit. Its brachial face is covered with cartilage, is rounded, and very convex. Its radial face is also covered with cartilage, and divided by two eminences, which extend from the back of the hand to the palm, into three parts, of which the posterior, larger than the other two, is convex and rounded; the central is also a little convex and square; finally, the anterior, the highest, is concave. The anterior face is triangular and a little concave and is also covered with cartilage. The ulnar face is rough in its anterior part, and its posterior is almost straight and covered with cartilage. The dorsal and palmar faces are slightly concave and have no cartilage.

§ 709. In the full grown fœtus this bone is ossified in its centre, but not very perceptibly; most of it is cartilage. Its ossification is not completed till the tenth year.

§ 710. It articulates by its brachial face with the semilunar bone (§ 696), by the upper part of its radial face with the scaphoid bone (§ 693), by its central portion with the trapezoides (§ 707), by its anterior face with the metacarpal bone of the third finger, by the cartilaginous portion of its ulnar face with the os unciforme (714).

§ 711. A ninth carpal bone sometimes exists between this bone and the preceding,* a curious analogy with the formation of apes, in which we find, between the trapezium and the os magnum, a ninth bone, which seems to rise from the division of the trapezoids into two portions.

IV. OF THE OS UNCIFORME.

§ 712. The *unciform bone* (*os hamatum*, s. *os unciforme*) has an irregular triangular form, the base being turned toward the back of the hand and the summit toward the palm. The latter portion, which is flat from one side to the other, forms the hook. The unciform process causes this bone to project very much inward beyond the central two, as the trapezium does outward, and produces, with the latter, the

* Salzmann, *Decas. obs. illustr. anat.*, Strasburg, 1725, p. 3.

inferior eminences of the carpus, which, united to the superior (§ 700), from the walls of a groove, through which pass the tendons of the flexor muscles of the hand and fingers.

The brachial face of the unciform bone is covered with cartilage, and is oblique, convex, and oblong. The external portion of the radial face is plain, and covered with cartilage; the internal is rough. The digital faces are slightly concave from without inward, a little convex from before backward, and divided by a slight ridge, which extends from the unciform process to the palmar side, into a small anterior and a larger posterior portion. The dorsal face is a little convex and rough. The palmar face, which is almost destitute of cartilage, is continuous by its external edge with the unciform process.

§ 713. We discover also in this bone, in the full grown fœtus, an osseous nucleus, situated near the centre, larger than that of the os magnum, although the unciform bone itself is smaller than this bone. Ossification is completed at the same time as in the preceding bone*.

§ 714. The unciform bone articulates by its brachial face with the pyramidal bone (§ 699), by its radial portion with the os magnum (§ 710), by its digital portion with the metacarpal bones of the fourth and fifth fingers.

II. OF THE METACARPAL BONE.

§ 715. The *metacarpus* is composed of five cylindrical bones, which vary in length, but are all formed after the same model. The *bodies* are rounded, or slightly triangular, convex on the dorsal side, concave on the palmar face, and a little broader toward the anterior end than near the posterior extremity. We distinguish in them three faces and three edges, which, except in the first metacarpal bone, in the anterior and posterior halves are situated differently. In fact the anterior or inferior portion presents a dorsal, a radial, and an ulnar face; also an internal, inferior, or palmar edge, a radial, and an ulnar edge, of which the first is more prominent. The posterior or upper half, on the contrary, presents two lateral faces, but not a superior, which is replaced by an inferior or palmar face; no palmar edge, but a dorsal, external, or upper edge; because the two lateral edges unite at the central part of the bone, and after leaving this point, a sharp edge extends on the back of the latter to its posterior extremity.

The *posterior extremity* or the *base* (*basis*) is triangular or irregularly quadrangular, and covered with cartilage at its posterior portion, which is generally plain. The lateral parts are also mostly covered with cartilage. Before and betwen the cartilaginous points of the lateral faces, are very considerable rough depressions, which are

* Albinus, followed by all the anatomists, says: "*Singula carpi ossa cartilaginea in fœtu sunt, nec nisi diu post nativitatem os inchoant*;" which is incorrect, according to our numerous examinations of full grown fœtal skeletons. We always find nuclei of bone in the semilunar and unciform bones: they are more imperfect than those of the tarsal bones, proportionally smaller, and not infiltrated with blood, but yellowish.

succeeded by similar projecting eminences: these are the vestiges of the connections of the metacarpal bones with each other and with those of the carpus, in such a manner as to admit of but very slight motion on account of the arrangement of their articular surfaces, of the number of means of union, and of the substance which forms them.

The *anterior extremity* is rounded, almost entirely covered with cartilage, and from its form is called the head (*capitulum*). It is a little compressed from one side to the other, and terminates backward on each side, both on the dorsal and palmar faces by two *tubercles* (*tubercula*), between which, on each side, is a large *depression* (*sinus*). These depressions and tubercles trace the insertion of the ligaments.

§ 716. Ossification of the metacarpal bones commences at the third month of pregnancy. They do not all appear at once: we see the second, then the third, and then the others appear. Towards the end of the third month each contains an oblong nucleus of bone. In the full-grown fœtus, the body only is ossified, and the two extremities are still entirely cartilaginous. They do not begin to ossify till very late; we see only one nucleus of bone in the head towards the end of the second year. This nucleus remains separate from the body for a long time, sometimes until the subject is fully grown. We have never seen it in the posterior extremity, except in the metacarpal bone of the thumb, which seems to have none in its head, at least we have never been able to see it in this part. The posterior or upper nucleus of the first metacarpal bone remains separated from the body as long as the anterior nuclei in the other four.

§ 717. The metacarpal bones articulate by their posterior cartilaginous faces, with the anterior range of the carpal bones: by the cartilaginous parts of the lateral wall of their bases, partly with these bones, and partly with each other; by their heads with the corresponding bones of the posterior phalanges.

I. OF THE FIRST METACARPAL BONE.

§ 718. The *first bone of the metacarpus*, or *the metacarpal bone of the thumb* (*os metacarpi policis*), varies from the others in size and in form. It is much shorter, but thicker and broader than the others, and relatively and absolutely flatter, while the latter are compressed, that is, are narrower from one side to the other, than from above downward. The dorsal face, the broadest of all, extends the whole length of the bone. The two lateral faces, of which the ulnar is the most extensive, unite at an angle much more obtuse than in the other metacarpal bones. The base is more broad than high, and has no cartilage on its two sides. Its posterior face is covered with cartilage, slightly concave from the radial to the ulnar side, a little convex from the dorsal to the palmar face, open on the two sides, and bounded only upward and downward by a slight projection. These particulars, and the extreme looseness of the capsular ligament, allow this bone much more motion than the other bones of the metacarpus. The head also is broader, but lower than in the others.

§ 719. The first metacarpal bone is one of those which is developed the last. In the fifth month of pregnancy, it is still, in proportion to the others, much shorter than it is afterward, since it is not more than one-half shorter than the fifth, which, when the body is perfectly developed is only one-seventh longer. Its mode of ossification differs from that of the others in a peculiarity mentioned above (§ 716).

§ 720. This bone articulates with the trapezium (§ 704).

II. OF THE SECOND METACARPAL BONE.

§ 721. The *second bone of the metacarpus*, or the *the metacarpal bone of the index finger*, is generally the longest of all, and extends backward farther than the others. The next one is seldom as long: the second is thinner than the third.. Its posterior extremity has a triangular articular face mostly faced with cartilage, which is very concave, and corresponds exactly to the convex digital face of the trapezoides (§ 707). On its radial face upward and backward, is a small plain cartilaginous surface. The ulnar face has another which is larger, occupying all the height of the bone, and divided by a slight projection into a smaller posterior portion, and an anterior part which is larger. This bone articulates by the cartilaginous part of its radial face, with the trapezium; by the posterior part of that of its ulnar face with the os magnum (§ 710); and by the anterior part with the third metacarpal bone.

III. OF THE THIRD METACARPAL BONE.

§ 722. The *third bone of the metacarpus* articulates with the os magnum (§ 710) by its posterior face, which is irregularly quadrilateral, broader above than below, convex from above downward, and covered with cartilage; with the second metacarpal bone, by the radial face of its base, which is covered with cartilage at its posterior part: finally, with the fourth, by two flattened cartilaginous surfaces, situated one above the other, as is seen in the ulnar side of the same part.

IV. OF THE FOURTH METACARPAL BONE.

§ 723. The *fourth bone of the metacarpus* is much shorter and thinner than the third. Its posterior articular surface is narrow, irregularly quadrilated, straight, and covered with cartilage, and corresponds to the anterior portion of the digital face of the unciform bone. Two small plane surfaces, which are covered with cartilage, and situated one above the other on the radial side of the base, are fitted to the corresponding surfaces of the ulnar side of the third metacarpal bone (§ 722). Another narrow surface, extending as high as the bone, is found on the ulnar side, and corresponds to a similar one on the radial side of the fifth metacarpal bone (§ 724).

V. OF THE FIFTH METACARPAL BONE.

§ 724. The *fifth metacarpal bone* is shorter, but thicker than the fourth. The articular face of its posterior extremity is quadrangular, convex, and covered with cartilage, and articulates with the anterior portion of the unciform bone. It articulates, by a small cartilaginous portion of its radial face, with the ulnar face of the fourth metacarpal bone (§ 723). The upper articular face presents, on the ulnar side, a blunt and rough tubercle.

III. OF THE BONES OF THE FINGERS.

§ 725. The fingers contain fourteen bones; each one, except the thumb, has three *phalanges* (*phalanges, articuli, internodia*). All the bones of the fingers are elongated, flattened from their dorsal to their palmar face; consequently more broad than high, convex from before backward on their dorsal face, concave on their palmar face, broader and stronger at their posterior than at their anterior extremity; and presenting, at least in the former, a slightly concave and cartilaginous articular surface.

§ 726. Ossification begins in the bodies of these bones later than in the metacarpal bones, and not until towards the end of the third month of pregnancy. The osseous nuclei of the first and third phalanges appear before those of the second. All these bones are developed by two points of ossification only; a larger for the body, and the other for the posterior extremity. This last begins to ossify about the age of five years; it remains separated from the body a long time, often even until the subject is perfectly developed. No special nucleus of bone exists in the anterior extremity*.

I. OF THE PHALANGES OF THE FIRST RANGE.

§ 727. The phalanges of the first range are the longest and strongest. The dorsal face of their bodies is very convex from one side to the other; the interior or palmar face is less so, but presents, in its centre, especially in the bones of the three middle fingers, a radial and an ulnar edge, which project very much into the centre of the hand, and are turned upon themselves. This projection is seen only in the first phalanx of the thumb. The posterior extremity presents a rounded articular process which is almost plain and covered with cartilage, and which articulates by arthrodia with the heads of the metacarpal bones. On the lateral parts, and below them, is on each side a very projecting edge. The upper face is rounded and triangular, and covered with cartilage, having in its centre a longitudinal furrow, which gives it the from of a pulley. On each side we observe a depression (*sinus*), behind which is a slight tuberosity.

* Albinus says that the two pieces of bone fuse directly with each other. (*Ic. os fœt.*, p. 120.) We have never observed a fact to support this proposition. Loder is likewise mistaken (*Anatomie*, p. 264) in saying that the anterior extremity also develops itself by a single osseous germ. Albinus had already given a correct description of the progress of ossification

Of these five bones that of the middle finger is the longest; those of the second and fourth fingers are nearly equal in length, and so too of the first and fifth; the latter however is a little longer than the other. That of the thumb is proportionally the broadest and flattest, which serves to distinguish it from that of the little finger.

II. OF THE BONES OF THE SECOND PHALANX.

§ 728. The *bones in the second phalanx* very much resemble those in the first, but they are flatter and broader in proportion to their length, especially in their posterior portion. The edges project very much in the central part of the second, third, and fourth, but less so than in the first phalanx. The posterior articular face fits into the pulley of the first phalanx; it is also divided by a projecting line into two small and slightly concave lateral facets; the interior has slightly the form of a pulley. In this range of bones that of the middle finger is the longest and the strongest; next come those of the fourth and second fingers; the shortest is that of the fifth finger.

III. OF THE BONES OF THE THIRD PHALANX.

§ 729 The third phalanx differs from the others, as its bones present an articular surface faced with cartilage only in their posterior parts. This face is much broader in proportion than their anterior extremity. The latter is less bulging, rough, rounded, and terminated by a tubercular edge. Besides, the bones in the third phalanx are much shorter than those of the other two ranges. Their posterior face is concave, and by a slight edge hollowed into two lateral cavities. The upper face is smooth, the inferior very rough, especially near the extremities. The phalangœal bone of the thumb in this range is much longer and thicker than the rest, which are smaller and nearly equal in length, but of different thicknesses; that of the little finger is much smaller than the rest.

B. OF THE ANOMALIES IN THE BONES OF THE HAND.

§ 730. The *bones of the hand* are sometimes partly or wholly deficient, which results from an imperfect development. In the former case, there are sometimes whole parts of which we can discover no traces, sometimes only portions of these parts are deficient, as for instance one or several bones of the phalanges.

So too the number of the bones is sometimes increased by one or more; this increase takes place in the number of the fingers, or of the other parts of the hand.

Sometimes the bones of two or more fingers are fused together.

A disease which does not belong exclusively to the bones of the fingers, but which very often attacks them, is a swelling, with a diminution in the density of their substance. This disease results from

inflammation, and is called *pœdarthrocase*, because observed most frequently in children, particularly those whose constitutions are feeble.

CHAPTER II.

OF THE BONES OF THE LOWER EXTREMITIES.

ARTICLE FIRST.

OF THE ILIAC BONES.

A. GENERAL REMARKS ON THE ILIAC BONES.

§ 731. The *iliac* or *coxal bones* (*ossa coxarum*, s. *pelvis lateralia*, s. *innominata*) correspond in form and situation to the shoulder-bones of the upper extremity. 1st. In form; being composed generally of two parts, one elongated and smaller, the other broader and larger. 2nd. In their situation; they are placed between the abdominal extremities and the lower part of the vertebral column, in the same manner as the bones of the shoulder are, between the second section of the pectoral limbs and the upper part of the vertebral column; their broad portion is situated backward and on the side, and their long portion forward, where the bones of the two sides meet, while the arrangement in the posterior face of the trunk is different. Comparative anatomy and the history of ossification place this analogy in a still stronger light.

§ 732. The iliac bone is divided into three parts, the *ilium* (*os ilium*), the *ischium* (*os ischii*), and the *pubis* (*os pubis*).

I. OF THE ILIUM.

§ 733. The *ilium* is the largest of these three portions. It corresponds to the scapula since it constitutes the broadest, the most posterior and the most superior part of the whole bone. Its form is irregular, more however like a triangle than any other figure. Its upper edge is convex; the anterior is usually straight and is grooved below; it is continuous with the ischium and the pubis by the anterior part of the latter.

§ 734. The upper convex edge is the largest and the broadest, especially forward and backward. It is called, from its form, the *crest of the ilium* (*crista ossis ilii*). We distinguish in it an external and an internal lip, and a middle portion. It terminates forward by a small eminence which projects above the anterior edge, and is called the *anterior* and *superior iliac spine* (*spina ossis ilii anterior superior*); backward, by two other projections, called the upper and lower *posterior iliac spines*, which are separated from each other by a small *semi-lunar notch* (*incisura semi-lunaris*).

The anterior edge, oblique from above downward, and from behind forward, presents two superficial notches which are separated by an eminence, the *anterior* and *inferior iliac spine* (*spina anterior inferior*).

In the inferior edge is a large notch; it forms the posterior and superior part of the *iliac notch* (*incisura iliaca*, s *iliaca superior*).

§ 735. The external and the internal faces are slightly concave, because the bone becomes thicker at its circumference; the internal however is more concave than the other. The upper part of the inner face is smooth, the posterior and inferior is very rough. The anterior and smaller portion of this rough part is faced with cartilage, elongated, convex forward and concave backward; it is called the *auricular surface* (*facies auricularis*). The posterior is more uneven and is destitute of cartilage.

The lower and by far the smallest part of the plane portion of this face, curves on the upper at an obtuse angle, and follows an almost perpendicular direction, while the upper extends obliquely from above downward and from without inward.

The angle which separates them forms, at the posterior part both upward and downward, between the smooth and the rough portions of the internal face, the *curved line* (*linea arcuata*). It is continuous forward with the posterior and projecting edge of the upper face of the horizontal branch of the pubis, thus producing all around the iliac bone a ridge, called the *linea innominata*. Immediately above this crest is found a large foramen through which the artery of nutrition passes to the bone.

The external face is smooth in every part and divided by two semicircular lines, which project slightly, being concave upward and backward, into two portions, the anterior of which is much greater than the posterior.

§ 736. The ilium is thickest downward and forward, where the inferior and anterior edges meet; forward and outward it presents a deep fissure, which forms the upper and external smaller portion of the *cotyloid cavity* (*acetabulum*). Some anatomists term this part of the bone the *body*.

II. OF THE ISCHIUM.

§ 737. The *ischium* (*os ischii*) forms the inferior central part of the iliac bone. It descends almost perpendicularly from the anterior part of the lower edge of the latter, but goes however a little from above downward and from without inward following the same direction as the lower part of the internal face of the ilium. In this place its internal face is slightly convex backward and very concave forward. The upper part is the broadest and thickest, and has also been called the *body*. The anterior portion of its external face forms the larger and lower part of the cotyloid cavity.

The posterior edge of the body is sharp; it forms the anterior part of the iliac notch, and runs backward and inward into the *sciatic spine* (*spina ossis ischii*).

The *descending branch* (*ramus descendens*) begins in this place. This branch is slightly compressed, but is very thick, and swells downward into the *sciatic tuberosity* (*tuber ischiadicum*), which is covered with cartilage. A deep furrow is found externally between this tuberosity and the lower edge of the cotyloid cavity. We remark also between it and the spine, on the internal face and posterior edge, the *inferior iliac* or *ischiatic notch* (*incisura iliaca inferior*, s. *ischiadica*).

The ascending branch leaves the tubercle, and goes inward, forward and upward. This branch is much shorter and weaker than the descending, and is compressed from before backward and from without inward.

III. OF THE PUBIS.

§ 738. The *pubis* (*os pubis*, s. *pectinis*) resembles the ischium in form, being also composed of two branches united at an angle. The *upper* or *horizontal branch* (*ramus horizontalis*) begins with the bulging external extremity of the *body*, by means of which it forms the upper and internal part of the cotyloid cavity; and then contracting, it also forms in its centre and at its origin a triangle. Toward its inferior extremity, it becomes considerably broad from within outward, becomes thinner from before backward, and thus produces its *descending branch* (*ramus descendens*), which goes downward and outward, gradually becomes narrow, and finally unites with the ascending branch of the ischium.

The inferior face of the horizontal branch is concave from behind forward and from without inward. The anterior edge, situated between the upper and anterior faces, is blunt. The upper, placed between the posterior and superior faces, forms the *crest of the pubis* (*pecten*, s. *crista*). Both unite, beyond the internal extremity of the horizontal branch and on the anterior face, in the *tubercle of the pubis* (*tuberculum ossis pubis*).

§ 739. The ischium and the pubis united represent an irregular ring, which surrounds an opening, closed in great part by a membrane, and called the *obturator* or *oval foramen* (*foramen obturatorium*, s. *ovale*). This foramen is, however, triangular or irregular quadrilateral. It has an external, an upper, and an internal edge.

The external edge, formed by the inner edge of the descending branch of the ischium and the outer part of the horizontal branch of the pubis, is longest, and is often divided into two portions, an inferior which is the smaller, and a superior. The upper part is always very broad, and forms a channel, the direction of which is from without inward and from behind forward, through which the obturator nerves and vessels pass from the pelvis. The abdominal viscera sometimes pass out through this opening, forming a hernia through the foramen ovale.

The upper edge, which is oblique from above downward, from behind forward, and from without inward, is formed by the inferior edge of all the inner part of the horizontal branch of the pubis, and unites at an obtuse angle with the internal.

The latter, oblique from above downward and from without inward, is formed by the upper edge of the descending branch of the pubis and of the ascending branch of the ischium, and it unites at an acute angle with the external.

§ 740. The *cotyloid cavity* (*acetabulum*) is situated on the external face of the iliac bone, in the place where the three pieces which form it meet. Its largest inferior portion is formed by the body of the ischium its smallest anterior portion by that of the pubis, and its posterior part by that of the ilium, that is, by the thickest portion of the iliac bone. It is round, rather deep, and surrounded by a sharp edge (*supercilium acetabuli*), which presents forward and downward, toward the foramen ovale, a considerable space, called the *cotyloid fissure* (*incisura acetabuli*). Its central and anterior part, the *sinus* (*fovea*), terminates anteriorly by a notch, and is uneven and rough, is grooved in several places, particularly in the upper and anterior region, and is destitute of cartilage. The upper and posterior, on the contrary, which is called the *semilunar face* (*facies lunata*), is smooth and covered with cartilage; it extends forward, and forms two *horns* (*cornua*) which surround the notch, so that the superior does not always descend entirely to it. The inferior is much more prominent, and forms with it a channel.

§ 741. The iliac bone is developed by three nuclei of ossification, which correspond exactly to the three parts we have described. These three parts are not however formed at the same time. First the nucleus of the ilium appears in the fourth month, next that of the ischium and lastly that of the pubis. Those parts which are most distant from the median line and from the anterior face are always developed first; so that they enlarge from without toward the median line. In the full grown fœtus, these three pieces are not only entirely distinct, but the ascending branch of the ischium and the descending branch of the pubis are but slightly ossified; so that there is more than half an inch of cartilage between them. At two years of age they touch, but the cartilage exists till the seventh year. About this period they unite with one another, although the three pieces of the iliac bone are still perfectly distinct, in the cotyloid cavity, in subjects of fourteen years of age. In the sixteenth year there is developed, in the cartilage which joins them in this place, a bone formed like a Y, which unites with the rest to form but a single bone. The formation however is not yet completed; for afterward, a single oblong nucleus of bone appears in the crest of the ilium, and a second along the inferior edge of the ischium. These do not unite till the age of twenty, and it is then only that the iliac bone is perfectly developed.

§ 742. The iliac bones articulate with the sacrum, with the coccyx, and with each other; viz. the ilium by its auricular surface and the rough portion behind it, with the sacrum, by synchondrosis; the ischium, with the sacrum the coccyx, and ilium by the two sacro-sciatic ligaments; the two descending branches of the pubis articulate together at their upper part by the intermediate fibro-cartilage.

§ 743. From the description given, the iliac bone differs from the

scapula in certain respects; but the analogy is greater than the differences, and the latter may be easily explained (§ 731). In the imperfect state the analogy is more striking, as is always the case: the broad part and the thin part do not make one, as in the adult, but they are separated; and it is still more remarkable in this respect, that although the pubis and the ischium form after the ilium, they however unite with each other before they join the last; so that taken together they represent the clavicle. Although the clavicle develops itself before the scapula, while the ischium and the pubis are formed after the ilium, yet this difference is of little importance. So too the difference in the manner in which these bones are articulated with each other and with the vertebral column, as also in the form of this articulation, which always continues, does not deserve notice.*

If we place a scapula and an iliac bone side by side, so that the internal edge of the former and the crest of the latter are directed upward, we recognise, without difficulty, that the inner, the anterior, and the outer edges of the scapula correspond to the crest, to the anterior edge, and to the iliac notch of the iliac bone; the glenoid cavity of the former, to the cotyloid cavity of the latter; the coracoid process, to the body of the pubis: finally, the spine of the scapula, to the body and descending branch of the ischium: the rest of the pubis and of the ischium represents the clavicle.

The horizontal portion of the pubis may also correspond to the clavicle, and the descending branch of the ischium to the coracoid process; since the ascending branch of the latter and the descending branch of the pubis are the costal cartilages ossified, and the fibro-cartilaginous mass between the descending branches of the pubis may be compared to the sternum in its unossified state.

B. OF THE ILIAC BONES ARTICULATED WITH EACH OTHER AND WITH THE LOWER BONES OF THE TRUNK, OR OF THE PELVIS.

I. NORMAL STATE.

§ 744. The *pelvis*† is a bony cavity situated at the lower extremity forming a part of the trunk, and it is composed of the sacrum (§ 491), and the coccyx which form it posteriorly, and by the two iliac bones (§ 731), which circumscribe it in the rest of its extent. The form of this cavity is very irregular, being much broader from one side to the other than from before backward, while it is much higher on the sides and backward than it is forward.

* See on this subject our *Beytræge*, vol. ii, p, 2. Comparative anatomy also demonstrates how unimportant is this difference,

† Ed. Sandifort, *De pelvi ejusque in partu dilatatione diss.*, Leyden, 1753.—J. Ripping, *Diss. sys. quasdam de pelvi animadversiones*, Leyden, 1776.—C. C. Creve, *Vom Baue des weiblichen Beckens*, Leipsic, 1791.—J. J. Watt, *Anatomico-chirurgical view of the male and female pelvis*, London, 1817.—G. Termanini, *Della figura, ampiezza, altezza, situazione ed osse della cavita del pelvi*, in *Opuscoli. scient. di Bologna*, vol. i. 1817.

§ 745. It is divided into the *large* and *upper pelvis*, and the *small* or *lower pelvis*. The large pelvis is the space circumscribed on both sides by the upper part of the iliac bones, backward by the upper face of the sacrum, and forward by the upper edge of the pubis, so that it is open forward and downward. It is separted from the lower pelvis by the *linea innominata*, or more properly the *linea terminalis*, the *terminal*, *marginal*, or *peripheric line*, which follows the anterior edge of the upper face of the sacrum, and by the promontory (§ 495), the boundary between the upper and lower parts of the iliac bones, and by the crest of the pubis. The surface comprised by this line is called the upper *opening* or *strait* of the *small pelvis* (*introitus*, s. *apertura pelvis superior*). The large pelvis is much broader across than from above downward, or from before backward, especially at its upper opening; for after leaving this point, its lateral walls, which are slightly concave, proceed obliquely downward and inward toward the inferior opening.

We distinguish in the large pelvis an *anterior* and a *posterior transverse diameter* (*diameter transversa posterior et anterior*), indicating, the first, the greatest distance between the two iliac crests, and the second, the distance between the anterior and posterior iliac spines.

§ 746. The *small* or *lower pelvis* is more rounded and more elevated than the large. Although broader from one side to the other than in any other direction, it is however much narrower than the latter; more surrounded than it by bony walls in all its circumference. Its walls are formed by the greater part of the sacrum, of the coccyx, of the ischia, and the pubes and the lower part of the ilia. The hollows in the walls of the small pelvis are filled by muscles and ligaments.

We observe in the small pelvis, the *entrance* or *superior strait* (§ 745) the *outlet* or *inferior strait* (*exitus*, s. *apertura inferior*), and the *cavity* (*cavum*), the space comprised between the two straits.

The upper strait has a rounded and oblong or elliptical form, and has a small process forward at its central part. We distinguish in it four diameters, an *antero-posterior* or *sacropubic*, the *conjugate diameter* (*diameter antero-posterior*), which is measured from the centre of the promontory to the centre of the symphysis pubis; the *transverse* or *iliac* (*D. transversa*), which extends from one side to the other, falling on the centre of the two sides of the *linea innominata;* the two *oblique diameters* (*D. obliquæ*, s. *diagonales*), which extend from the sacro-iliac symphysis of one side to the union of the pubis and ilium of the opposite side, and are distinguished into right and left. The oblique and transverse diameters are longer than the conjugate diameter.

The walls of the cavity of the pelvis are a little oblique from above downward. We distinguish in this cavity a *straight* diameter, a *transverse* and two *oblique* diameters. The first reaches from the union of the second and third sacral vertebræ to the centre of the symphysis pubis. The transverse diameter extends from the centre of one cotyloid cavity to the same point in the opposite cotyloid cavity The oblique is measured from the inferior extremity of the sacro-iliac

symphysis to the centre of the foramen ovale of the opposite side: they are the longest, and the straight diameter is longer than the transverse.

The *inferior strait*, or the *outlet*, is narrower than the other regions, but it can enlarge an inch, as the bones of the coccyx are moveable. It is formed by the lower edge of the coccyx, the two sacro-sciatic ligaments, the ascending branch of the ischium and the descending branch of the pubis; so that it is composed of three large arches, viz. two lateral, situated between the coccyx and the sciatic tuberosities, and an anterior, which is larger, and is found between the two latter tuberosities. We distinguish in it only two diameters, a straight and a transverse. The *straight* or *cocci-pubic* diameter extends from the centre of the lower extremity of the coccyx to that of the lower edge of the symphysis pubis; the second or ischiatic, is measured from the centre of the lower edge of one sciatic tuberosity to the corresponding point of the other. When the coccyx is pushed back, the straight diameter increases in breadth, so that it becomes greater than the transverse; but otherwise, in the normal state, they are equally long.

Besides these imaginary lines, we admit also an *axis* (*axis linea*, *directionis pelvis*),* that is, a line passing through the centre of the pelvis from above downward, but which, from the irregular form of this cavity, is not exactly parallel to its walls. This line is convex backward, and concave forward. We may suppose it produced by two or three straight lines, which unite at an obtuse angle in the centre of the straight diameter of the cavity of the pelvis: the upper line is the axis of the superior strait, the lower, that of the inferior strait, and the central one, of the cavity of the pelvis. They are directed, the first from above downward, and from before backward; the other two from before backward, and from behind forward.

The axis of the pelvis has not the same direction as that of the body, and the angle it forms with this last is not the same in all its extent, for this angle gradually contracts from above downward: so that it may be estimated about thirty degrees upward, twenty-five in the centre, and eighteen downward.

The surface, near the centre of which these lines are supposed to pass, is called the *surface of inclination*; and the difference between the direction of the pelvis and that of the trunk is termed the *inclination* (*inclinatio*) *of the pelvis*.†

§ 747. The pelvis is undoubtedly that part of the body which varies the most in the two sexes, on account of its relations with the function of generation. The differences it offers in this respect, are then very important, and deserve to be examined particularly.

The general characters of the female pelvis are its breadth and depth; those of the male pelvis are its narrowness and height.

The lateral walls of the superior pelvis in the female have a more oblique direction downward: they are less deeply grooved from before

* J. G. Rœderer, *De axi pelvis programma*, Gottingen, 1751.—Sommer, *Der Axe des weiblichen Beckens*, Brunswick, 1781.

† G. G. Stein, *De pelvis situ ejusque inclinatione diss.*, Marburg, 1797.

backward, or from above downward, separate very much from behind forward, and are much broader in this direction than in the male, which makes them appear lower.

The small pelvis is more spacious, less elevated, and more uniformly broad, than in the male, especially in the transverse direction. The circumference of the female pelvis is more rounded and elliptical, while in the male it is heart-shaped, because its walls first separate a little from each other from behind forward, they then converge and approach insensibly, before uniting forward. The upper part of the sacrum in the male projects much more inward than in the female, a difference depending principally on what is observed in the form of this bone (§ 496) and on the greater breadth of the central part of the pubis in the female.

In the female the iliac bones where their upper and lower portions unite, project very much beyond the sacro-iliac symphysis, while in the male they go almost directly forward. In the female the horizontal portion of the pubis extends almost in a straight line from without inward, after leaving the anterior edge of the cotyloid cavity; instead of which, in the male, it goes directly forward. Hence it follows that the superior strait of the small pelvis in the female is broader, and its transverse and oblique diameters particularly are proportionally larger than the straight diameter.

The small pelvis has nearly the same breadth in every part in the female; that of the male, on the contrary, becomes much narrower from above downward, because in the female pelvis the ilium and the ischium descend almost in a straight line, while in the male they approach each other very much while descending; and also because the sacrum is much straighter in the female, not projecting so far backward in its centre, nor so much inward in its lower portion, hence the sciatic tuberosities are much nearer each other in the male.

In the same manner, these bones and the pubis, and consequently all the small pelvis in the male is much higher than in the female.

The foramen ovale is much higher and narrower in the male, less elevated and broader in the female; it is more oval in the former and more triangular in the latter.

Finally, the outlet in the male is much narrower than in the female. The distance between the two sciatic tuberosities being much greater, the ascending branches of the ischia and the descending branches of the pubes meet in the female only after describing a large arch (*arcus ossium pubis*), while they unite at an acute angle (*angulum ossium pubis*) in the male. Besides in the male the descending branches of the pubes are turned, so that one of their faces looks more forward and the other more backward, while in the female the arch they describe causes their anterior face to look more outward and the posterior more inward, an arrangement which renders the difference in the form of the interior strait still more evident. Thirdly, the branches of the pubes being much thinner in the female, the inferior strait of the pelvis is broader.

The most essential difference then between the male pelvis and that of the female in respect to breadth and form arises principally from the lower strait, which in the male is not only narrower but also heart-shaped and terminated forward in a point, while in the female it is rounder.

§ 748. The important differences in the form and breadth of the pelvis in the two sexes will be more evident from a table of the comparative measurements of the diameters of the cavity of the pelvis taken from subjects of the same height.*

	MALE PELVIS.		FEMALE PELVIS.	
Transverse diameter of the large pelvis.	in.	lin.	in.	lin.
1st. Between the anterior and superior iliac spines	7	8	8	6
2nd. Greatest distance	8	3	9	4
Transverse diameter }	4	6	5	0
Oblique do. } of the superior strait . .	4	5	4	5
Straight do. }	4	0	4	4
Transverse do. }	4	0	4	8
Oblique do. } of the cavity	5	0	5	4
Straight do, }	5	0	4	8
Anterior transverse diameter }	3	0	4	5
Posterior do. do. } of the outlet . .	3	0	4	6
Straight do. do. }	3	3	4 and sometimes 5 in.	4

II. OF THE ANOMALIES OF THE PELVIS.

§ 749. The anomalies peculiar to the female pelvis† are principally deviations of formation, which are congenital or accidental, and which affect the bones themselves, or their connections. All these deviations are very important as they exert a pernicious influence upon the functions of generation, especially upon parturition.

§ 750. 1st. The anomalies of these bones are seen in the variations presented in their form and situation, or in their continuity.

a. Anomalies in form. The slightest abberration consists generally

* The calculations forming the basis of this table differ a little from those of Chaussier See Mad. Boivin, *Mém de l'art des accouchemens*, p. 26—29.

† C. C. Creve, *Von den Krankheiten des weiblichen Beckens*, Berlin, 1795.—Mad. Boivin, *Mém. de l'art des accouch.*, p. 31—34.

in an *increase* or a *diminution* of *capacity*, which causes a general largeness or narrowness of the pevis. These two states however, more particularly the second, when existing in a certain extent, are more rare than anomalies in the form of one or more bones, whence the figure of the whole pelvis varies more or less from the ordinary proportions either because only one of these regions is deformed, or because, even when the anomaly extends to the whole pelvis, a single diameter is shortened, so that the cavity is contracted in only one direction. These different kinds of anomalies are by no means equally common.

Most usually the antero-posterior or conjugate diameter of the upper and lower opening of the pelvis is narrower, because the sacrum describes too great a curve, whence its upper and lower extremities project too much inward. At the same time the pelvis is almost always oblique, which renders the oblique diameters unequal. The transverse diameter generally preserves its proper proportions, but is sometimes unusually broad. As to the straight diameter of the cavity, it is often unusually and uselessly long, from the great concavity of the sacrum.

The shortening of this straight diameter however may result also from an anomaly in the form of the iliac bones, they being either too short, or because, although large as usual, they describe an arch which is too convex.

The effect is the same also when the pubes are not properly arched externally, but go directly inward after leaving the ilium. A narrow space is then formed forward which does not assist the passage of the fœtus, although the straight diameters are not really shortened.

Sometimes only the conjugate diameter of the outlet of the pelvis is shortened by the ossification of the ligaments of the coccyx. The shortening of the transverse diameter of the superior strait is rare, but that of the inferior strait, especially backward, is common, from the bending inward of the sciatic tuberosities.

Curvatures of the vertebral column, although extensive, have no effect upon the form of the pelvis, when not resulting from a general disease, as particularly rachitis. We have satisfied ourselves of this by a careful examination of a great many skeletons of hunch-backs.

b. Anomalies in situation. They cause a change in the direction or in the inclination of the pelvis. This cavity is inclined farther forward, and its distance from the horizontal line is greater as its axis is more perpendicular. On the contrary, it slopes very much more backward, and is more oblique as its axis is more horizontal.

c. Anomalies in the continuity of the bones. These consist in fractures, which are not impossible as has sometimes been thought, but are observed in the pelvis even more frequently than in the other parts of the trunk. The part of the walls of the pelvis most frequently broken is the ilium, and the fracture is either transverse or longitudinal; a fracture of the descending branch of the ischium is most unfrequent. The horizontal and descending branches of the pubis and the ascending branch of the ischium almost always break together. Fractures

of the sacrum are for the most part transverse; they are seldom seen except in the body of this bone.

§ 751. 2nd. Anomalies in the arrangement of the connections of the bones of the pelvis consist in too loose or too firm a union.

a. Looseness in connection is primitive or accidental. The primitive is seen almost exclusively in the symphysis pubis. It is rarely met with alone,* and is almost generally attended with an analogous anomaly in the bladder, a fissure of this organ. The bones are then always very imperfectly united by a fibrous ligament, which renders the gait unsteady, and the more as the pubes are generally separated some inches.

Accidental separation results either from external violence or disease, as inflammation and suppuration, by which the ligaments are torn or destroyed. External violence fractures the bone sooner than it destroys the ligaments, excepting always the pieces of the coccyx, which are moveably articulated with the sacrum and with each other.

b. Too great solidity of the connections, the fusion of the bones, is caused by the ossification of their fibro-cartilages or of their fibrous ligaments.

This is seen most frequently in the sacro-iliac articulation, especially in that of the right side, which depends probably on the greater compression of this joint, from the support afforded to the body by the lower extremity of the right side.

It is less common to find a fusion either of a few, more particularly the lower of coccygœal bones, or of all, or finally of the first coccygœal bone with the sacrum. This anomaly is more frequent in males, especially equestrians, than in females.

The ossification of the sacro-sciatic ligaments is still more rare. That of the symphysis pubis is still more so.† It generally but not always results from inflammation and destruction of the cartilage, while that of the other joints supervenes without inflammation, and solely from the gradual change of their proper substance, and of the fibrous tissues which surround them.

ARTICLE SECOND.

OF THE FEMUR.

§ 752. The *femur* (*os femoris*) is not only the largest of all the cylindrical bones, but the greatest bone in the body. It is stronger than any other round bone, and so curved at its upper part, that it is convex forward and concave backward. Its upper extremity differs much from that of the body; for the almost spherical head which terminates it

* Walter mentions one case in his work, *Von der Spaltung der Schambeine*, Berlin, 1782.

† E. Sandifort, *De ancylosi ossium pubis*, in the *Obs. anat. pathol.*, book i. chap. vi. p. 115-125, tab. viii.

joins to this last at nearly a right angle, by a short but very manifest neck. Near the centre of the cartilaginous surface of this head, but rather downward than upward, is a considerable depression, which marks the insertion of the round ligament. The neck is slightly compressed from before backward. At the place of its union with the body we remark two large processes, called *trochanters* (*trochanteres*). The *large, upper,* or *outer trochanter* arises from the upper and outer extremity of the body, curves very much backward and downward, and presents on its internal face a considerable depression, called the *fossa of the large trochanter.* The *inner, smaller,* or *inferior trochanter* is situated lower than the preceding, and arises as a small truncated pyramid from the upper extremity of the internal face of the body, and inclines inward. Ridges extend from the large to the small trochanter on the anterior and posterior faces of the bone, and give attachments to certain muscles. These are called the *anterior* and *posterior and intertrochanterian lines* (*linea intertrochanterica anterior et posterior*); the latter is by far the most distinct.

The anterior and external faces are so insensibly continuous with each other on the body, that we cannot trace the limit between them; and the bone is here round. The anterior and the internal faces are very distinct, and the external and the internal are still more so, as a very projecting ridge, called the *rough line of the thigh bone* (*linea aspera ossis femoris*), exists between them. This ridge arises by two roots from the large and small trochanters, is more or less evidently divided into two *lips* (*labia*) in almost the whole length of the femur, and terminates by two branches at the lower sixth of the bone. The base of the body is also divided into four faces; an anterior, a posterior, and two lateral faces, which are the narrowest.

The inferior extremity of the body extends into an inferior process. This, the broadest and straightest part of the bone, has, generally considered, the form of a heart. We notice its two *condyles* (*condyli ossis femoris*), an *external,* and an *internal,* the inferior, anterior, and posterior faces of which are insensibly continuous with each other and thus form a broad surface, which is convex from before backward and from within outward, and is covered with cartilage. These two eminences are separated in every part by a fissure, which is very deep, especially in its posterior portion, where it is not covered with cartilage. This posterior part is the *posterior intercondyloid fossa* (*fovea intercondyloidea posterior*). The anterior is much flatter, is covered with cartilage, forms a part of the articular surface, and is called the *anterior intercondyloid fossa* (*fovea intercondyloidea anterior*). The two lateral faces of the condyles, which are destitute of cartilage, present elevations which serve for the attachment of the articular ligaments.

The *foramina of nutrition* (*foramina nutritia*), are found upon and near the side of the linea aspera, but at different heights. We usually observe two, one of which is larger than the other, and is always situated higher. Sometimes also there is only one, which is then found near the centre of the femur.

§ 753. The femur appears first toward the end of the second month of pregnancy, at which time its length but slightly exceeds its breadth and thickness. From the third month, however, it not only becomes longer, but its two extremities are evidently broader than its central portion: it, however, remains straight till birth, and its curve is not apparent till toward the end of the first year, and afterwards gradually increases. In general it is larger in the male than in the female. Ossification does not commence in the lower extremity till the last month of pregnancy; a single rounded osseous nucleus then occupies the central portion, from whence it gradually extends to the two condyles Some time after birth ossification begins also in the upper extremity, namely, in the head; but it is not till the third or fourth year that ossification begins first in the large and then in the small trochanter. The neck, which is simply the body prolonged, is indicated but very imperfectly in the full grown fœtus, and only on the inside by the greater breadth of the upper part of the bone, as also by the projection of its upper extremity. These five osseous germs, that of the head, of the body, of the two trochanters, and of the condyles, remain separated a long time after puberty, and are not all fused, even when the subject is perfectly developed. The small trochanter first fuses with the body, next the head, then the large trochanter; the inferior extremity is fused the last.* This marked difference then exists between the ossification of the humerus and femur, that in the latter the lower, and in the former the upper extremity is the last to unite with the body.

§ 754. The femur articulates by its upper extremity with the iliac bone, and by the lower with the head of the tibia.

§ 755. The greatest anomaly presented by it is a great increase of its curve forward: this is seen principally in subjects affected with rachitis. More rarely the groove in the head for the insertion of the round ligament is deficient (§ 752). When the lower extremities are very imperfectly developed, this bone is sometimes wholly or at least in great part deficient.

ARTICLE THIRD.

OF THE BONES OF THE LEG.

§ 756. The leg, like the fore-arm, is composed of two bones, which differ in their relations with each other and with the adjacent bones, from those of the bones of the second section of the pectoral members. The larger is the *tibia*, the smaller the *fibula*.

I. OF THE TIBIA.

§ 757. The *tibia* (*focile majus*) forms the foundation of the leg, being five times as massive as the fibula. This bone is next in size to the

* Albinus mistakes in saying that the two trochanters fused at the same time and does not point out the order in which the different nuclei of bone are developed

femur, and is longer even than the humerus. It is situated on the inside of the leg.

The direction of its body is almost straight; it is however slightly convex forward and a little concave backward. Its three faces are perfectly distinguished from each other by projecting edges. The anterior edge, which separates the internal from the external face and is directly under the skin, is sharp, and has hence been called the *crest of the tibia* (*crista tibiæ*); the external is acute; the smoothest and most rounded of the three is the internal. The external face is concave in its uppper two thirds, and is called the *peronæal cavity* (*cavitas peronæa*) from the direction of its hollow. The internal and posterior face is slightly convex. Above its central part the body is a little compressed from within outward, but gradually enlarges in its lower fourth and becomes more rounded, because its edges disappear in this portion of it.

There is generally but one foramen of nutrition, situated at the inferior extremity of the first fourth of the posterior face, near the outer edge.

The upper extremity, the thickest and broadest part of the bone, terminates in the *condyles of the tibia* (*condyli tibiæ*), which correspond to those of the femur. Both present on their upper faces, which are faced with cartilage, a *superficial glenoid cavity* (*cavitates glenoideæ, externa et interna*). Their internal edge alone projects slightly, especially in the centre. Their internal articular face is a little longer from before backward, but narrower in the same proportion from within outward, than the external face. They unite inwardly and produce an unequal *elevation* (*acclivitas intercondyloidea*), the direction of which is from before backward, but which is not as extensive as they are. This elevation corresponds to the posterior intercondyloid fossa of the femur. Before and behind it we observe an anterior and a posterior depression (*fovea acclivitatis anterior et posterior*), which has no cartilage. At the posterior extremity of the lateral face of the external condyle of the tibia is a small, round, smooth articular surface (*facies articularis lateralis*, s. *peronea*), faced with cartilage, the direction of which is obliquely downward and backward, to which is fitted the corresponding facet of the upper extremity of the fibula. The anterior face of this upper extremity presents in its centre, at the place where it unites with the body, a considerable projection, called the *spine* or *tuberosity of the tibia* (*tuberositas tibiæ*), which is insensibly continuous with the crest.

The lower extremity forms in its lower convex portion a considerable triangular tuberosity, the angles of which are however rounded; this is called the *internal malleolus* (*malleolus internus*); on its posterior face is a groove, more or less deep, and the direction of which is from above downward and from without inward; it is the *internal malleolar groove* (*sulcus malleoli interni*). The external face of this extremity, on the contrary, is concave and receives the fibula. The lower face, which forms a right angle with the external face of the internal malleolus, is

faced with cartilage, slightly concave from before backward to lodge the head of the astragalus, and is sometimes divided into two lateral portions by a slight eminence.

§ 758. The tibia develops itself by three points of ossification. The body appears toward the end of the second month of pregnancy. The osseous germ of the upper extremity does not appear till towards the last month, and then is seen in its centre. The inferior is wholly cartilaginous in the full-grown fœtus, but begins to ossify immediately after birth. The fusion of these pieces of bone with the body is not completed till the subject is perfectly developed. The lower extremity fuses with the body before the upper extremity.*

§ 759. The tibia articulates by the upper faces of its condyles with those of the femur; by its lateral articular facet with the head of the fibula; and by its lower extremity with the astragalus

§ 760. The anomalies of this bone are its entire or partial deficiency, which accompanies the imperfect development of the lower extremities, their curving inward (*valgi*) or outward (*vari*), or rarely forward in those affected with rachitis.

II. OF THE FIBULA.

§ 761. The *fibula* (*perone, focile minus cruris*) is the second, and the weaker of the bones of the leg, being situated on its outside. It is nearly as long as the tibia, but does not extend so high above, while it extends a little below the tibia. The body has an irregular form, and it is twisted on itself. We however distinguish in it three faces, which are very sensibly separated by as many edges. The anterior is not simply concave, but divided, in most of its extent, by a longitudinal crest into two parallel furrows. The external is concave in its upper part, and slightly concave downward. The internal is flatter, but in its upper part are prominent asperities for the attachments of some muscles. The anterior edge is the most acute, especially near the central part of the bone, and hence it may be called the *crest of the fibula* (*crista fibulæ*). The body of the fibula is much thicker in its centre and towards its upper extremity than in the rest of its extent.

The foramen of nutrition, which is always single, is situated a little above the centre of the bone on its internal edge.

The upper extremity, the *head* of the fibula (*capitulum*), represents an irregular square, the upper face of which is directed obliquely from above downward, and from behind forward, and has on its posterior part an articular surface, which is cartilaginous and a little concave, which corresponds to the lateral articular facet of the tibia (§ 757). This surface presents asperities, more or less distinct, to which muscles are attached.

The lower extremity is triangular, and slightly compressed from right to left: it descends backward a little lower than forward, and forms the *external malleolus* (*malleolus externus*). The upper and

* Albinus has neglected to mention the order in which the nuclei of bone in the tibia are developed and fused.

interior portion of its internal face unites to the lower face of the inferior extremity of the tibia, at a right angle, to form the articular surface designed to receive the astragalus, and is covered with cartilage. The posterior and inferior half is rough, and very concave: it is called the *fossa of the external malleolus* (*fovea malleoli externi*). Above and behind this fossa, and also before and above the articular surface, are two tubercles, a posterior and an anterior (*tubercula malleolæ externæ posterius et anterius*), to which ligaments are attached. The posterior face of the external malleolus presents a groove (*sulcus malleoli externi*), which is perceptible with difficulty.

§ 762. The body of the fibula appears a little later than that of the tibia. In the fœtus of ten weeks old, it is only about half as long as this last; and it is not till the end of the third month that both bones have the same length. On the contrary, even in the full-grown fœtus and in the child, the tibia is thinner in proportion to the fibula than at a later period. The two single osseous nuclei of the extremities do not begin to appear till after birth, and fuse only when the subject is fully grown. The inferior unites to the body before the superior, and always sooner on its external than on its internal edge.

§ 763. The fibula articulates upward with the tibia, (§ 759), and downward with the astragalus (§ 772).

§ 764. This bone is sometimes deficient when the lower extremities are not perfectly developed, although the tibia may exist; a curious analogy with some animals, resembling the fusion of the two bones into one, as it is seen in several. Its lower part is then generally deficient; sometimes however, although the tibia and the foot exist, (the latter being very imperfect) the upper part of the fibula is deficient, and only a small portion of its lower part exists, which terminates upward in a point.

III. OF THE PATELLA.

§ 765. The *patella* or *rotula* is a shorter bone situated on the anterior face of the knee joint, between the femur and the tibia. It has an irregularly quadrilateral form. The angle produced by the union of its lower edges is the most acute, and that by the upper, the most obtuse. The anterior face is convex, and presents numerous foramina of nutrition; the posterior is covered with cartilage in all its upper portion, and is divided by a large projection into two slightly concave surfaces. This part is covered with cartilage, and is fitted to the anterior part of the articular surface of the lower extremity of the femur. The lateral fossæ receive the anterior parts of the condyles, and the central eminence is fitted into the anterior fossa.

The patella is situated in the substance of the tendon of the extensor muscles of the leg, which covers all its anterior face, but extends only upon those parts of its posterior face which have no cartilage. This tendon attaches it to the tuberosity of the tibia. It corresponds perfectly, both in its situation and in its connection with this tendon to

the olecranon process of the ulna; and hence the tibia has no process which may be compared with the olecranon. The patella increases the analogy between the bones of the leg and those of the fore-arm.

§ 766. Ossification of the patella does not commence till after birth. Portal is mistaken in saying that its posterior face is almost perfect in the full-grown fœtus, and that it is developed by two points of ossification.* A nucleus of bone forms in the centre of the cartilage, and gradually and slowly enlarges. We very rarely find several points of ossification; Rudolphi however mentions an instance.†

ARTICLE FOURTH.

OF THE BONES OF THE FOOT.

§ 767. The *foot* comprises three divisions, the *tarsus*, the *metatarsus*, and the *toes* (*digiti pedis*).

I. OF THE TARSUS.

§ 768. The *tarsus* is formed like the carpus of short and rounded bones very similar to the carpal bones, but differing from them in several respects, viz. in number: the bones of the tarsus are only seven; they are much larger and stronger, their mode of articulation with the bones of the leg differ, and they are arranged, not like the bones of the hand, in two rows, most commonly, but in three. On the other hand, the manner in which they articulate with each other, or with the metatarsal bones, is almost the same as that of the carpal bones, and it is much more exact to describe them as forming two rows.

I. OF THE POSTERIOR RANGE OF THE TARSAL BONES.

§ 769. The posterior range of the tarsal bones comprises the two largest, the *astragalus*, and the *os calcis*.

A OF THE ASTRAGALUS.

§ 770. The *astragalus* (*talus*, *astragalus*, *os tesseræ*) has a quadrangular but very irregular form. We distinguish in it a *body*, a *head*, and a *neck*.

The body is quadrangular, and is the posterior and largest part of the bone. Its upper face is covered with cartilage, is convex from before backward, and slightly concave from within outward. The direction of the upper part of the external lateral face is obliquely from above downward and from within outward, and, like the smaller and

* *Anat. Med.*, vol. i. p. 472.
† *Anat. physiol. Abh.*, p. 133.

upper part of the internal face, it is covered with cartilage. The inferior parts of these two faces which have no cartilage, present numerous asperities for the attachment of ligaments. The small posterior face is also uneven, and extends outward into a small tubercle. The inferior is covered with cartilage, is directed a little obliquely from without inward and from before backward, and is very concave. The anterior is not free except in its inferior half, and to a small extent of the outside of the superior; it is continuous for the most part with the neck, which is short and very narrow upward, downward, and outward. The head is a little higher than the neck and extends much lower, but does not like the neck proceed outward as far as the body. Its upper face is rough. The anterior is convex from without inward and from above downward, is much more broad than high, and is covered with cartilage. The latter is usually divided into two portions by a slight eminence, the direction of which is oblique from before backward, and from without inward. Sometimes, but rarely, a portion which has no cartilage divides into two entirely distinct surfaces; these differences however do not depend on sex, nor is the arrangement on both sides of the same subject exactly the same.

§ 771. The rudiments of the astragalus appear first in the seventh month of pregnancy. In the full-grown fœtus, it is a round nucleus of bone, the body and the head being then almost equal in size.

§ 772. The astragalus articulates, by the upper and lateral faces of the body, with the tibia (§ 759) and the fibula (§ 763), forming a ginglymus joint, which besides the flexion and extension of the foot, admits only of a slight motion inward and outward. It articulates by the lower face of its body and its neck with the os calcis (§ 775), and by the anterior face of its neck with the scaphoid bone (§ 779).

B. OF THE OS CALCIS.

§ 773. The *os calcis* (*calcaneum*) is the largest of the tarsal and even of the short bones, and is more than double the size of the astragalus. It is situated below the astragalus and proceeds equally as far forward, but extends much further backward. Its general form is irregularly quadrilateral. Its greatest diameter is from before backward, and the smallest from within outward.

We may distinguish in it a *body* and an *internal process*.

The *body* is compressed laterally. It bulges backward and forms a large *tuberosity* (*tuber calcanea*) to which the Achilles tendon is attached, and which terminates downward and forward in two eminences, the internal being larger than the external. The external face is rough; it usually presents forward two small tubercles, which however are not constant, and seldom exist in both bones of the same subject. These tubercles, one of which is situated directly behind the other, form a species of groove. The outer face is generally smooth, the inner is a little concave from above downward and from before backward. The upper face forms two arches, the posterior of which

is smaller and flatter, and extends from the upper extremity of the tubercle to the posterior extremity of the anterior arch. This latter is larger, and is composed at its anterior face of a cartilaginous convex articular surface, having a direction perpendicularly from behind forward, and of another portion situated forward, rough, very concave, and destitute of cartilage. In this place, the bone is much lower than in its posterior portion. Its anterior triangular face is slightly concave and covered with cartilage.

From the upper and internal edge of the anterior portion of the os calcis proceeds an oblong process, not broad but very strong, which goes inward, and is called the *lateral process* (*processus lateralis, sustentaculum tali*), on which the head of the astragalus rests. This process is separated, backward and upward, from the body, by a deep groove (*sulcus sustentaculi tali inferior*). The uppper face descends obliquely from before backward; it is covered with cartilage and is concave. Its anterior part is usually narrower than the posterior, and most generally there is at the commencement of the anterior third a greater or less contraction, which is sometimes converted into a deep furrow, destitute of cartilage, which seems to divide its single face into two parts. This face corresponds to the inferior face of the body of the astragalus. Its division into two is much more common than the same arrangement in the astragalus, and the lower face of the head of this bone is not usually divided, even in those subjects where the separation of the upper face of the lateral process of the os calcis is complete.

The assertion that this articular surface is entire only in the female is incorrect;* on the contrary, its division into an anterior and a posterior part is much more frequent in the female than in the male, where it is rare and less perfect. Farther, in both sexes we not unfrequently find the two arrangements in the two sides of the same subject, so that there are no peculiarities of sex.

§ 774. The os calcis is developed the first of all the tarsal bones. It begins to appear in the sixth month of pregnancy as a single nucleus in the centre of the cartilage. In the full grown fœtus, this nucleus is nearly twice as large as that of the astragalus and goes farther forward, but very little farther back than the latter, while in the adult the posterior forms almost half of the length of the bone. This difference arises from the fact that three-fourths of the os calcis at least, particularly all its posterior part, is still cartilaginous, and its osseous nucleus is situated directly below that of the astragalus. Afterward, that is from the eighth to the tenth year, there is developed in the tuberosity, a single, flat, and rounded osseous germ, which is much thicker downward than upward, and which increases from below upward. The lower part of this nucleus fuses with the body much sooner than the upper part. Sometimes also a third point of ossification forms in the upper part of the tuberosity. The perfect union of

* Sœmmerring, *Knochenlehre*, p. 410.

this nucleus with the body takes place only when the subject is fully grown. The form of the os calcis, its slow development, and its connexions with the Achilles tendon, are circumstances worthy of remark, as establishing an analogy between it and the patella, and the olecranon process of the ulna.

§ 775. The os calcis unites to the bones of the leg, but does not articulate with them, although attached by strong fibrous ligaments. It articulates by the upper articular surface of its body, with the body of the astragalus; by the upper articular surface of its process, with the head of the same bone (§ 772); and by the anterior face of its body, with the cuboid bone (§ 782).

II. OF THE ANTERIOR RANGE OF THE TARSAL BONES.

§ 776. The anterior range of the tarsal bones is formed of five bones, which are smaller than those of the posterior range, and of which four articulate with the latter by their posterior extremities, while the fifth is situated between the three internal bones of this range and the posterior range. Two of these bones, the scaphoid bone and the cuboid bone, are usually considered as the second range of tarsal bones, because their posterior faces articulate with the astragalus and the calcaneum; but as the cuboid bone also extends as far forward as the other three which are usually considered as the third range, and as it articulates like the latter with the metatarsal bones, it is more proper to regard these five last as forming only one range.

A. OF THE SCAPHOID BONE.

§ 777. The *scaphoid bone* (*os naviculare*) is situated before the astragalus, behind the three cuneiform bones, and on the inside of the cuboid bone. It makes part of the posterior and internal portion of the anterior range of the tarsal bones. Its breadth exceeds its height very much, and its thickness still more. Its posterior cartilaginous face is concave and smooth; its anterior is larger and also covered with cartilage, convex, and divided by three eminences which extend from above downward, into four compartments, which diminish in extent from within outward. The upper and convex face is very rough. So too with the inferior which is straighter. At the place where these two faces meet, on the internal edge of the foot, the bone forms a projecting angle, called the *tuberosity* of the *scaphoid bone* (*tuberositas ossis navicularis.*)

§ 778. Ossification of the scaphoid bone does not commence till after birth, and usually towards the end of the first year.

§ 779. This bone articulates by its posterior face with the anterior face of the head of the astragalus (§ 772), and by the four compartments of its anterior face with the three cuneiform bones (§ 784, 793), and also with the cuboid bone. (§ 782).

B. OF THE CUBOID BONE,

§ 780. The *cuboid bone* (*os cuboideum*) derives its name from its form, which is irregularly quadrilateral. It is longer from before backward than from one side to the other, and from above downward. Its posterior triangular face is covered with cartilage, and is slightly concave; the internal is rough in most of its extent; it is covered with cartilage at its central and upper portion: this cartilaginous surface is divided into two halves by a process which goes from above downward, of which the external half is the larger. The anterior face situated on a short, slightly contracted eminence, is square, covered with cartilage, and also divided by a projection which goes from above downward into two halves, of which the external is the larger. The upper face is almost plane and slightly uneven. The external is the smallest, and in the place where it is continuous with the inferior, it forms a tuberosity which also extends across the whole breadth of the inferior face and which produces the *oblique eminence of the cuboid bone* (*eminentia obliqua ossis cuboidei*). Between this tuberosity and the anterior edge of the face, a deep furrow (*sulcus ossis cuboidei*) extends in an oblique direction. The portion of the external face situated behind the tuberosity is also concave and rough, but less so than the other.

§ 781. Ossification of the cuboid bone commences before birth, but not till towards the end of the eighth month of pregnancy, although it is far advanced in the full grown fœtus.*

§ 782. This bone articulates by its posterior cartilaginous face with the anterior face of the body of the calcaneum (§ 776); by the posterior half of the portion of its internal face which is covered with cartilage, with the most external and smallest compartment of the anterior face of the scaphoid bone (§ 779); by the anterior part of this same portion, with a part of the external face of the third cuneiform bone (§ 792); finally by its anterior face with the posterior extremities of the two external metatarsal bones.

C. OF THE CUNEIFORM BONES.

§ 783. The *three cuneiform bones* (*ossa cuneiformia*), which have received this name from their common resemblance to a wedge, are situated between the scaphoid, the cuboid, and the three inner metatarsal bones. They are all triangular, contracted from within outward, and much broader at one extremity than at the other, where they terminate by a more or less sharp edge. They are not equal in size.

* Albinus says *Maturo (fœtu) etiam nonnisi calceus et talus portem osseam habent*, and every anatomist has followed him. But this is a mistake, as may easily be seen by examining the skeleton of a full grown fœtus.

a. Of the first cuneiform bone.

§ 784. The *first cuneiform* is called also the *large* or *internal cuneiform bone* assists to form the internal edge of the sole of the foot. It is situated between the inner part of the scaphoid bone and the metatarsal bone of the large toe. It is very much larger than the other two, and from its position, the sharp edge is directed upward. Its free inner larger convex face is very rough. The external is a little concave, is still more rough. We remark along its upper and most of its posterior edge a straight band, which is covered with cartilage and divided forward by a small eminence in two parts; the anterior is smaller, and is directed a little obliquely from behind forward and from within outward. The inferior face is slightly convex and very rough. The anterior, almost plane, is in the form of an ear, that is, it is surrounded inward by a convex edge, and outward by a concave edge slightly grooved at its central part. The posterior is triangular, concave, and entirely covered with cartilage.

§ 785. In the full grown fœtus there is no nucleus of bone for the large cuneiform bone.

§ 786. It is articulated by its posterior face, with the most internal compartment of the anterior face of the scaphoid bone (§ 779); by the greater posterior part of the cartilaginous portoin of the external face, with the second cuneiform bone (§ 789); by the small anterior part of the same portion, with the second metatarsal bone (§ 799); finally, by its anterior face, with the posterior face of the first metatarsal bone (§ 797).

b. Of the second cuneiform bone.

§ 787. The *second cuneiform bone*, called also the *smallest cuneiform bone*, is about one third the size of the preceding. It is particularly much narrower from above downward and from before backward, so that its extent downward or forward is not so great, although upward and backward it proceeds as far as that. It is situated so that its broad face forms a part or the back of the foot, while its lower, sharper, and wedge-shaped edge looks towards the sole. The upper face is square, convex, and slightly rough; the posterior and anterior are triangular, straight, and covered with cartilage. Most of the internal edge is also covered with cartilage; it is destitute of it in but two small slightly concave spaces, the posterior of which extends nearly in a straight line from the centre of the lower edge to the upper, without however reaching it, while the anterior occupies the lower part of the anterior edge. The external face is covered with cartilage in its upper and posterior part, and is uneven and rough in its anterior.

§ 788. Ossification does not begin in this bone till after birth, and a little later even than in the large cuneiform bone.

§ 789. The second cuneiform bone articulates by its posterior face with the second compartment of the anterior face of the scaphoid

bone (§ 779); by the interior, with the first cuneiform bone (§ 786); by the external, with the third cuneiform bone (§ 792); and by the anterior, with the second metatarsal bone (§ 799).

c. Of the third cuneiform bone.

§ 790. The *third cuneiform bone* is about half the size of the first. The form and direction of its faces resemble those of the second very much, but it is a little more contracted from within outward than the last. It is as long from before backward as the first, so that it proceeds equally as far forward; but as it is lower and does not equal it in height, it does not extend equally as far downward.

The larger and upper portion of its triangular and plane posterior face is faced with cartilage; so too of the upper and posterior half of the external face, while its inferior and anterior part, which is more extensive than the other, is uneven and rough. Almost all the internal face is very rough and destitute of cartilage. We only perceive a layer of cartilage some lines broad, along the upper part of its posterior edge, and two others, which are smaller and rounder, situated one above the other, and occupying nearly the same extent along the anterior edge. The anterior face is slightly concave and triangular, and is every where covered with cartilage.

§ 791. The third cuneiform bone, although much smaller than the first and the scaphoid bone, ossifies before them, and it appears not in the full-grown fœtus, but at the end of the first month, as an osseous germ which is very considerable.

§ 792. It articulates by its posterior face, with the third compartment of the anterior face of the scaphoid bone (§ 779); by its interior face, with the third metatarsal bone (§ 801); by the posterior and cartilaginous part of the internal, with the second cuneiform bone (§ 789); by the two anterior cartilages of the same face, with the second metatarsal bone (§ 801); finally, by the cartilaginous portion of its external face, with the cuboid bone (§ 782).

II. OF THE METATARSAL BONES.

§ 793. The *metatarsus* is composed, like the metacarpus, of five cylindrical bones, which are formed generally after the same type, and are nearly equal in length; but which independently of several less important differences, vary much in thickness. Like all cylindrical bones the body is thinner than the extremities, and presents three faces, which are separated by as many edges: the inferior is usually the sharpest. Among these faces, one looks more or less upward, and is called the *superior* or *dorsal* (*faces dorsalis*): the other two are lateral, an *external* and an *internal*. The bone, considered as a whole, is slightly arched; hence it appears slightly convex above and more strongly concave below.

The posterior extremities or the *bases* (*basis*), are generally triangular. They terminate backward by more or less plane and cartila-

ginous surfaces, by which they articulate with the anterior range of the tarsal bones. They are also furnished on one or on both sides with one or more facets, by which they are fitted to each other and to the bones of the anterior range of the tarsus. Besides, part of the lateral faces of these posterior extremities is rough for the insertion of fibrous ligaments.

The anterior extremities or the *heads* (*capitula*), are generally thinner than the posterior, rounded and terminated forward by an articular convex surface, behind which is a *depression* (*sinus*) which surrounds all the head. Beyond this depression we observe four tubercles, one at the upper and the lower part of each side.

As the anterior and posterior extremities of the metatarsal bones extend beyond the body in every direction, we observe between every two of the metatarsal bones an interval called an *interosseous space* (*interstitium interosseum*).

§ 794. The metatarsal bones gradually form by the union of two pieces of bone. The largest, which represents the body, appears first in the third month of pregnancy, and is perfectly developed in the full-grown foetus. The processes do not begin to ossify until the second year. These two pieces of bone do not fuse entirely till about the period when the subject is perfectly developed; but they do not all unite at the same time in all the metatarsal bones. It is remarkable, that here, as in the metacarpus, the first bone differs from the four others, by the development of its second germ in the base, instead of forming in the head as is does in the latter, which renders this and the metacarpal bone of the thumb similar to the first phalanx of the hand and foot.

§ 795. The metatarsal bones articulate by their posterior faces, with the anterior range of the tarsal bones; most of them by their posterior faces, with each other; and by their anterior extremities, with the first phalanges of the toes.

I. OF THE FIRST METATARSAL BONE.

§ 796. The *first metatarsal bone*, or the *metatarsal bone of the great toe*, is much larger, but shorter than the other. Of the three faces of its body, the upper is inclined a little inward, the internal is concave and inclined downward; and the external is almost plane, and its direction is perpendicularly from above downward. The internal and external edges unite with each other at an obtuse angle, and with the superior edge at a right angle. The base is very elevated, in proportion to its breadth, and backward presents an ear-shaped surface, the convex edge of which looks inward, and the concave edge outward. We often, but not always find, at the upper part of the external lateral face of its posterior extremity an oblong, plane or slightly concave cartilaginous articular facet, which corresponds to an analagous facet of the second metatarsal bone.

The head is broader than those of the other metatarsal bones, and the articular facet is divided by a strong longitudinal crest into two depressions, which extend from the centre to the posterior edge, and of which the external is deeper than the internal.

§ 797. The first metatarsal bone articulates by its posterior extremity, with the anterior face of the large cuneiform bone (§ 786); sometimes by the external lateral face of its base with the second metatarsal bone (§ 799); by the upper part of its interior extremity, with the posterior extremity of the first phalanx of the great toe; by the inferior, with the two sesamoid bones, which are found in the flexor muscle of the great toe.

II. OF THE SECOND METATARSAL BONE.

§ 798. The *second metatarsal bone* is the largest of all, and extends further backward than the others, except the fifth. Its base has the form of an equilateral triangle, the summit looking upward: it is very concave, especially at its upper part, and its external edge is very much notched. The internal lateral face presents a plain cartilaginous facet, which varies in situation, sometimes existing directly before the internal edge and at the highest part of the posterior face, and sometimes much more forward and downward, and separated from this edge by a groove for the attachment of a ligament. The external facet presents two articular facets, situated one above the other, and separated by a depression which varies in size, extent, and form: the upper differs considerably, being sometimes very long from before backward, and divided into two parts by a longstitudinal eminence; sometimes it is shorter and single, or at least is divided imperfectly,

The upper face of the body is turned entirely inward, whence the internal edge is in fact the upper. The depression situated between the anterior articular facet and the tuberosities, is broader than in the following bones of the metatarsus.

§ 799. The second metatarsal bone articulates, by its posterior face with the second cuneiform bone: by the internal lateral face of its posterior extremity, in the formation first described (§ 798), with the large cuneiform bone; and in the second mode (§ 798), with the first metatarsal bone (§ 797); by the anterior segment of the upper portion of the external face of its base, with the third metatarsal bone (§801): by its posterior segment, with the third cuneiform bone (§ 792), a connection which is somtimes perceptible with dificulty, and is often defficient; finally, by its lower face, with the third metatarsal bone (§ 801) and the third cuneiform bone (§ 792), and sometimes with only one of them.

III. OF THE THIRD METATARSAL BONE.

§ 800. The *third metatarsal bone* is frequently the shortest of all. It is compressed laterally in all its length. Its posterior extremity

advances a little farther than that of the second. Its posterior articular face is also triangular, but a little narrower and even. Directly before the posterior edge of the internal lateral face we observe, sometimes, one facet, and sometimes two, situated one above the other, and separated by a depression which presents no cartilage. This facet has a a rounded triangular form. The external lateral face presents one which is always single, but more extensive, situated exactly opposite the internal. The body and the head are formed as in the preceding bone.

§ 801. This bone articulates by the posterior part of its base, with the third cuneiform bone (§ 793); by the internal face, with the second metatarsal bone (§ 799); by the external, with the fourth (§ 803); and by the anterior face of its head, with the first phalangeal bone of the third toe.

IV. OF THE FOURTH METATARSAL BONE.

§ 802. The *fourth metatarsal bone* is usually a little longer and always extends back farther than the third. It is less compressed from one side to the other than the second and the third; hence its body is more rounded and its upper face is turned directly upward, while the other two are turned to the sides. The posterior face of the base is lower than in the second and third metatarsal bones, is oblong, and a little more concave. On the internal lateral face is a surface which is sometimes single and sometimes divided into two unequal parts by a perpendicular eminence, and which is separated from the posterior face by the attachment of a ligament. This surface is oblong and very extensive, slightly convex, and covered with cartilage; it occupies the upper half of this face. The external lateral face presents a similar triangular, flat, articular surface, which extends to the posterior face, both before and below which is the attachment of the ligament.

§ 803. This bone articulates by its posterior face, with the internal segment of the anterior face of the cuboid bone (§ 782); by the internal, sometimes with the third metatarsal bone alone (§ 801), sometimes as in the second (§ 802), by the posterior segment of the cartilaginous face with the third cuneiform bone, which then presents a small cartilaginous facet at the anterior and upper part of its external face; finally by the external lateral part of its base, with the fifth metatarsal bone.

V. OF THE FIFTH METATARSAL BONE.

§ 804. The fifth metatarsal bone has the same length as the fourth. It differs in form from all the others. The body is not compressed from one side to the other or rounded, but flattened from above downward, especially in its external portion, formed by the upper and external faces, the last of which has become entirely inferior, and which are separated from each other by a sharp edge. The body also is thicker than the bodies of the second, third and fourth metatarsal bones. The

base is triangular and compressed, not from right to left but from above downward, which makes it more broad than high. Its posterior face is very oblique from behind forward and from without inward. Its base is not, as in the other metatarsal bones, entirely covered with cartilage; this is seen only on its internal portion, which is flat, triangular, and almost rounded, while the external is smaller and separated from the preceding by a perpendicular fissure, and has a considerable *eminence* (*tuberositas*), which is rounded and turned outward, and which renders the bone very broad in this part. The internal face of the base has on its upper part a broad, flat facet which is covered with cartilage. The head is more broad than high; it is also often narrower and lower than the body. From the great convexity of the internal face of the fifth metatarsal bone and the slight concavity of the external face of the fourth, the fourth interosseous space is very narrow.

§ 805. This bone articulates by its posterior face, with the external segment of the anterior face of the cuboid bone; by the internal face of its base, with the fourth metatarsal bone; and by its head, with the first phalangeal bone of the fifth toe.

III. OF THE BONES OF THE TOES.

§ 806. We count fourteen bones in the toes, each one having three phalanges excepting the large toe (*hallux*), which has only two. These bones of the phalanges belong to the class of long bones, and resemble perfectly in their most essential characters those of the fingers (§ 725, 726).

I. OF THE FIRST PHALANX.

§ 807. The first or the posterior phalanx is the longest. The two extremities of these bones are much thicker than the body, especially the posterior, which is much higher and broader than the anterior. The body on its inferior face is concave from before backward and straight from one side to the other. The upper is straight in the first direction and very convex in the second. These two faces are separated from one another by an external and an internal lateral edge.

The *posterior extremity*, the *base* (*basis*), presents posteriorly a very concave articular surface, which is rounded and broader in the phalanges of the first and fifth toes than in the others. We observe on each side, where the upper face is continuous with the lower, a very projecting *tubercle* (*tuberculum*).

The anterior extremity, or the *head* (*capitulum*), is broad, and forms before an articular surface, which is slightly concave from above downward and presents on each side a rounded *depression* (*sinus*), behind which we see a tubercle.

Among the phalanges of the first range that of the large toe is the largest. It differs also from the others in being flat and contracted from above downward.

§ 808. These bones are developed much later than those of the metatarsus, and generally do not begin to appear till toward the end of the fourth month of pregnancy, except in the first phalanx of the large toe, which appears sooner than the others.

§ 809. They articulate posteriorly with the anterior extremities of the metatarsal bones, and anteriorly with the posterior extremities of the bones in the second phalanx.

II. OF THE SECOND PHALANX

§ 810. The *bones of the second phalanx* (*phalangini*) are generally constructed after the same type as those of the first; but they differ from them: 1st. In their length, which is less, although they are nearly as broad; hence they are nearly as broad as they are long. 2d. They are much flatter from above downward. 3d. There is less of difference in respect to the thickness of their bodies and extremities, which sometimes do not differ. 4th. The forms of their articular surfaces vary; in fact the posterior is broader and divided by a longitudinal projection into two slightly concave lateral portions, while the anterior, which is slightly concave, does not present the longitudinal groove at its central part.

§ 811. Ossification does not commence till after the fifth month of pregnancy.

§ 812. These bones articulate by their posterior extremities with the heads of those in the first phalanx, and by their anterior with the posterior extremities of the third range of bones.

III. OF THE THIRD PHALANX.

§ 813. The *bones of the third phalanx* (*phalanx tertia*, s. *unguinis*) are composed of a very small body, of an anterior and a posterior extremity, which are larger. The posterior extremity on its posterior face is covered with cartilage, rounded, oblong, much more broad than high, and simply concave, except in the first, where this surface is divided by a slight eminence into two lateral parts. The edge of the posterior face is surrounded by a depression, before which are numerous asperities which extend all round the bone. The anterior extremity or the *summit* is rounded and very rough.

§ 814. This phalanx ossifies before the second. The anterior phalanx of the first toe appears sooner than the posterior and even than all the other phalanges. The point of ossification is not developed first in its centre but at its summit.

§ 815. These bones articulate by their posterior extremities with the anterior extremities of those in the second range. They are often fused with the latter; this must doubtless be ascribed to pressure, since the fusion is usually observed in the external toes, on which compression acts with most force.

SECTION IV.

COMPARISON OF THE BONES IN THE DIFFERENT REGIONS OF THE BODY.

§ 816. Like all the organs, the bones of the right and left sides are the most similar: the analogy is even so great between them in this direction that it is almost equivalent to a perfect resemblance, since the differences are too slight to be noticed.

We consider next the longitudinal direction: here we observe, 1st. that the bones of the upper and lower halves of the trunk correspond.

The central region of the trunk, that which is formed by the dorsal vertebræ, the ribs, and the bones of the sternum, divides into an upper and a lower half; for the ribs diminish very much in length both above and below the præcordial region, and the upper and lower pieces of the sternum may be compared to each other, since both terminate by jagged edges.

The lumbar and the cervical vertebræ are analogous in their want of ribs. The greater number of the cervical vertebræ is compensated for by the greater volume of the lumbar.

The head corresponds to the sacrum and the coccygæal bones.

But the analogy between the bones of the upper and lower extremities is striking. This analogy is seen:—

1st. In the number of the divisions of the limbs. In fact each extremity is divided into four regions or sections.

2d. In the form and the number of the bones which serve as the bases of each of these regions.

The iliac bone of the lower extremity corresponds to the scapula and the clavicle of the upper. The two extremities differ, as the upper possesses two bones, while one only is found in the lower; but this difference is unimportant, and besides it does not exist in the early periods of life. The iliac bone is formed by the union of three principal pieces: the posterior, the largest and broadest, called the *ilium*, corresponds to the *scapula*; the anterior, narrower, called the *pubis*, represents by its body the coracoid process, and by its horizontal branch the external part of the clavicle; the inferior, which is thicker, called the *ischium*, corresponds by its body and descending branch, to the acromion process of the scapula, and by its ascending branch to the anterior part of the clavicle. The crest of the ilium and the base of the scapula, the coracoid process and the pubis, the acromion process and the ischium, are developed by special nuclei of ossification.

We find only one bone in the arm and one in the thigh; they correspond perfectly in form and mode of development. Both have a rounded head, and the tubercles of the humerus represent the trochanters of the femur. At the lower extremity we see a surface in the form of a pulley, constituting a ginglymus joint.

The fore-arm and leg have each two bones which are very analogous. The upper extremity of the ulna terminates in a pulley like that of the tibia. These two limbs present a bone which articulates by ginglymus with that of the second division. True, the upper extremity of the ulna rises much higher than that of the tibia, but this is owing to a peculiar piece of bone which corresponds to the patella. This last ought to be considered as a process of the tibia, which never unites with the body of that bone; and the olecranon process of the ulna also sometimes remains, like it, distinct and separate from the ulna through life.*

The lower extremity of the ulna differs from that of the tibia by its smallness, but that of the radius is very similar to the inferior extremity of the fibula, which should be considered as a true compensation, since in the motion of pronation the upper extremity of the radius comes below the upper extremity of the ulna. In fact if we unite the lower portions of the ulna and radius, we obtain a bone very similar to what the tibia would be if the patella were joined with it. This analogy is rendered still more evident by another circumstance,—that the bones which succeed the tibia correspond to the anterior extremity of the radius; and it is favoured also by comparative anatomy. In most quadrupeds, pronation is the proper state of the anterior extremity, so that the lower extremity of the radius is always situated on the inside. In others, the ulna does not extend to the carpus; and as for this reason its lower extremity does not articulate directly with any bone of the carpus in man, so the tibia unites to the fibula in most quadrupeds, and only the former bone descends to the tarsus. The upper and lower extremities of the tibia present on their fibular face a cartilaginous facet, like those on the radial face of the ulna, by which the two bones articulate with each other.

In this manner the analogy between the fore-arm and the leg becomes much more evident. The ulna and the tibia however on one side, and the radius and the fibula on the other, resemble each other in this point of view also, that the upper extremity of the first two possesses the greatest volume, while in the latter two the inferior is the largest.

Both bones run on their lower extremities and on the sides which are opposite to them rounded extremities, constituting the styloid processes and the malleoli. The radius is shorter than the ulna, and the fibula is shorter than the tibia, more especially if the patella be united with it.

The analogy between the bones of the hand and foot is very evident

Those bones which correspond the least are the bones of the carpus and tarsus, which differ very much in size, those of the former being about a fifth as large as those of the latter, and being arranged also in a different order. We may however discover great analogies between them. The posterior carpal range corresponds to the os calcis, the astragalus, and the scaphoid bone. The anterior part of the scaphoid bone of the hand resembles perfectly that of the foot. These bones are

* Delachenal, *Obs. anat. med.*, Bâle 1706, § 28.—Rosenmüller, *De oss. variet.*, Leipsic, 1804, p. 62.

situated at the side of, and not over each other; and we find more in the hand than in the foot, as the former requires more motion and the latter more solidity. Hence why several bones of the posterior range articulate with the carpal extremity of the bones in the fore-arm and with the bones of the anterior range.

The number of the bones in the anterior range which articulate directly with the metacarpus and the metatarsus is the same. It is especially remarkable that both extremities of the last two bones of the middle section (the metacarpus and the metatarsus) are supported by but one bone, while each of the other three articulates with two bones.

The arrangement of the articular faces which unite the bones of the anterior range with each other, or with those of the metacarpus and metatarsus, are very similar. Thus the trapezium and the first cuneiform bone present forward a small facet, by which they articulate with the second metacarpal and second metatarsal bone. The second metacarpal bone on its ulna side and the second metatarsal bone on its fibular side present an articular surface, divided into two portions, of which the anterior articulates with the succeeding metacarpal or metatarsal bone, and the posterior with the third cuneiform bone in the foot and the os magnum in the wrist. The third, fourth, and fifth metacarpal and metatarsal bones do not articulate, except with the corresponding bones of the carpus by their posterior face, and rarely articulate with each other.

The metatarsal and metacarpal bones resemble each other also in number, form, mode of development, and connections. In both, the first of these bones present analogous proportions, although not entirely similar in regard to the others, for they are thicker than these. The second is longer both in the hand and foot. The tubercle which increases the size of the fifth metatarsal bone exists at least in a rudimentary state in the fifth metacarpal bone. The first metacarpal and the first metatarsal bones differ from the others in their mode of development and in the same manner.

The phalanges of the fingers and toes are also formed on the same fundamental type, and however great may be the difference between them, they are modifications of the same formation.

The *differences* between the bones of the upper and lower extremities depend on the differences of their functions. They may be referred, 1st, to the greater solidity necessary for the pelvic limbs to sustain the trunk and the head, and the greater degree of mobility necessary to increase the relations of the organism with external objects; 2d, to the greater mass of the inferior extremities.

Hence why the iliac bones are united with each other and with the sacrum by a fibro-cartilaginous mass which admits of no motion, and why the anterior and posterior pieces of the iliac bone on each side fuse into one, while the scapula remains distinct from the clavicle. Hence also the reason that the scapula is attached to the vertebral column only by muscles, and that the clavicle is united in front with that of the

opposite side, the sternum and the first rib, only by loose synovial and fibrous ligaments. Hence, finally, the reason that the internal edge of the bones of the pelvis is very broad and that of the scapula very thin.

The cotyloid cavity of the femur is very deep, the corresponding glenoid cavity of the scapula is on the contrary flat, so that the scapulo-humeral articulation is secured only by the adjacent processes and by the external ligaments.

Hence the head of the femur is much larger than that of the humerus. We cannot perceive at all on this last a depression to receive the round ligament which strengthens the ilio-femoral joint within the capsule.

The body of the humerus is twisted, that of the femur is almost straight and arched in only one direction.

The humerus is destitute of a neck, and its tuberosities are not distinctly marked. The trochanters in the femur are largely developed, and the neck, which is very long, separates from the body to extend the head into the cotyloid cavity.

The differences observed in the lower ends of the two bones, and in the arrangement of the knee and elbow joints, produce exactly the same effect.

In the upper extremities the articular surfaces are surmounted on each side by large condyles which do not exist in the lower extremities. In the latter the joint is a ginglymus, and deep depressions exist between the two condyles of the femur and asperities between those of the tibia. There we find, beside the ginglymus articulation which is more plane, a rounded head, for the rotatory articulation with the radius.

In the lower extremity one bone only, the tibia, is connected with the femur; the fibula articulates only with the tibia, of which it in some measure forms a part. In the upper extremity both bones of the fore-arm articulate with the humerus, and the radius moves very freely. The bones of the fore-arm, which are united above and below by loose attachments, and which are nearly of the same size, can be displaced in several different way in relation to another, and these changes allow the hand to perform very important motions. The firm union of the bones of the leg, both at their upper and lower parts, and also the fact that the fibula from its small proportional development should be considered as a part of the tibia, causes the two bones to be almost motionless upon each other, and the motions of the foot to be simply flexion and extension.

The articulation of the foot is much more firm than that of the hand, both because the malleoli descend very low, and from the form of the articular surfaces of the bones of the leg and astragalus, whence these bones articulate with only one bone of the tarsus.

The bones of the tarsus are attached to one another by very solid bands; the pisiform bone, which is loosely articulated, is entirely deficient, or rather this bone is represented by the sesamoid bone in the tendon of the peroneus longus muscle.

Their mass exceeds that of the bones of the carpus ten times.

The bones which are situated at the side of each other in the carpus, are arranged before each other in the tarsus.

The metatarsal bones are larger, narrower, and more contracted, while those of the metacarpus are broader, concave, and better disposed to grasp and hold objects.

The metatarsal bone of the great toe is much stronger and thicker than the metacarpal bone of the thumb, and cannot separate itself from the others as this can.

The same differences exist between the phalanges of the fingers and toes as between the metacarpal and the metatarsal bones ; only those of the toes, excepting the first, are much shorter and more imperfectly developed.

The phalanges of the toes are the only exceptions to the second of the general differences pointed out between the two limbs, since they are smaller than those of the corresponding fingers.

§ 817. The resemblances between the anterior portions of the body and the posterior are in this as in the other systems the slightest of all. We however have already shown that the sternum corresponds to the vertebral column, the frontal bone to the squamous portion of the occipital bone, the arches to the bodies of the vertebræ.

BOOK II.

SYNDESMOLOGY.

§ 818. Under the head of *Syndesmology** we shall describe only the modes of union between the bones and the cartilages which cover their extremities. The connections between other organs, as the muscles and the viscera, will be mentioned when speaking of those organs.

The bones are connected by very different substances, and the degree of motion between the bones which are united varies exceedingly. Descriptive syndesmology however treats of the two classes of ligaments, the *synovial* or *capsular* (§ 367), and the *fibrous* or *accessory* (§ 299).

As these organs are intimately connected with the bones, it will be better to describe them in the same order. Hence we shall mention, first, the ligaments of the trunk, then those of the head, and conclude with those of the extremities.

SECTION I.

OF THE LIGAMENTS OF THE TRUNK.

§ 819. The *ligaments of the trunk* are divided into those of the *vertebral column*, of the *ribs*, and of the *sternum*.

* The principal books of reference are, J. Weitbrecht, *Syndesmologia*, seu *Historia ligamentorum corporis humani*, Petersburgh, 1742.—*Desmographie*, ou *Description des ligamens du corps humain*, Paris, 1752.—M. Alberti, *Nützliche Lehre von der Articulationen des menschlichen Körpers*, Freyberg, 1745.

CHAPTER I.

LIGAMENTS OF THE VERTEBRAL COLUMN.

§ 820. The vertebræ are attached to one another in all parts of their surfaces by fibrous or fibro-cartilaginous ligaments, and in some parts by capsular ligaments also; the former serve to retain these bones in their places and to confine their motions, while the latter facilitate their motions. but are also covered externally by fibrous ligaments.

The principal ligaments of the vertebral column are, 1st, *the intervertebral fibro-cartilages*, which are of all the modes, the strongest bonds of union; 2nd, the *synovial capsules*, situated between the articular processes and which facilitate their motions.

These two kinds of ligaments are strengthened, as in all parts, by fibrous fasciculi, placed directly upon them, or which are attached to the other parts of the vertebral column. These fasciculi are the *anterior* and the *posterior vertebral* ligaments, the *accessory fibres of the capsular* ligaments, the *yellow* ligaments, the *interspinal*, and the *intertransverse* ligaments.

We had better consider first the fibrous and fibro-cartilaginous ligaments, and then the synovial capsules.

I. FIBROUS AND FIBRO-CARTILAGINOUS LIGAMENTS.

I. BETWEEN THE BODIES OF THE VERTEBRÆ.

A. ANTERIOR VERTEBRAL LIGAMENT.

§ 821. The *anterior vertebral* ligament (*fascia longitudinalis anterior, ligamentum corporibus vertebrarum commune anterius*) covers the anterior and convex face of the bodies of the vertebræ. It extends from the centre of the anterior part of the large occipital foramen which Weitbrecht has wrongly disputed, to the last bone of the coccyx.

It is composed of longitudinal fibres which do not extend uninterruptedly from one extremity of the column to the other, but cover in fact only a single vertebra, and which unite above and below on the surface of the intervertebral ligaments with those of the adjacent vertebræ.

The fibres are thicker on the vertebra than in any other part; they grow thinner and shorter as they approach the upper and lower faces of the bone. Hence the anterior surface of the vertebral column is more uniformly convex than it would be without this arrangement, since the bodies of the vertebræ are concave from above downward.

Besides the straight fibres, we also find many which are oblique; these cross the former at a very acute angle.

This ligament is thicker, and its fibres are much closer in its centre than on the sides. The fibres separate very much from each other on the two sides of the median line, while on the contrary they unite backward so that they form three bands, the central of which is the strongest while the two lateral bands are weaker.

The ligament covers all the anterior face of the bodies of the vertebræ; it is not confined to the centre and to sending only irregular prolongations to the sides. Its lateral parts are composed of longitudinal fibres as regular as those of the central portion; and they differ so little in their essential characters from the periosteum, that the ligament may be regarded as a periosteum more developed. We cannot at least refuse it this character in most of the vertebral column, especially in the dorsal, the lumbar, the sacral, and the coccygæal regions. In the cervical vertebræ, especially the upper two, the anterior ligament assumes still more the appearance of a very thick, rounded, and very projecting band, which covers only the centre of the anterior face, while the fibres on the lateral parts of the bodies are thin and irregular. This difference doubtless exists because the anterior face of the cervical region is covered with muscles, which are not found in the other regions of the vertebral column. The latter part of the anterior ligament in these last, appears in the neck as the tendons of the anterior muscles of the neck. So too on the second lumbar vertebra, this ligament becomes the tendons of the diaphragm.

The narrowness of the anterior ligament on the upper cervical vertebræ depends upon the great degree of motion possessed by these bones, and being formed in this manner their motions are not so much obstructed.

This ligament is not equally thick on all the vertebræ. Its thickest parts cover the upper cervical and dorsal vertebræ, the thinnest are found on the superior lumbar vertebræ.

It not only unites the bodies of the vertebræ forward, but also prevents the column from bending too much backward.

B. POSTERIOR VERTEBRAL LIGAMENT.

§ 822. The *posterior vertebral* ligament (*fascia*, s. *ligamentum commune posterius*) extends along the posterior face of the bodies of the vertebræ, within the medullary canal.

It diminishes in breadth from above downward; in the cervical vertebræ it is as broad as the bodies of the vertebræ; it is much thinner on the sides in the dorsal vertebræ, and finally disappears entirely in the lumbar regions, becoming a single waving band situated on the median line, being a little broader on a level with the upper and lower faces of the bodies of the vertebræ.

At the same time, it is attached to the intervertebral substance more firmly than to the posterior face of the bodies of the vertebræ.

Its relations with the vertebræ and with the dura-mater are not exactly the same. In most of the vertebral column, it is intimately connected with the bodies of the vertebræ, and it is attached to the dura-mater only by a loose mucous tissue. But at the third cervical vertebra its relations with these vertebræ changes, since the ligaments extending from the head to the cervical vertebræ form, between it and their posterior faces, a peculiar fibrous mass, *the fibrous mass between the head and the cervical vertebræ*, to which that ligament adheres but very slightly as far as the upper extremity of the vertebral column.

In its first portion, it unites as usual to the dura-mater; but at the upper extremity of the vertebral column it is so closely connected with this membrane that some skill is required to separate them; hence the separation between the fibrous membrane of the central portions of the nervous system and the largely developed periosteum of the vertebræ begins in this place.

In the same place the posterior vertebral ligament unites intimately with the fibrous mass between the head and the cervical vertebræ.

This ligament limits, to a certain extent, the flexion of the vertebral column forward.

C. INTERVERTEBRAL LIGAMENTS.

§ 823. The *intervertebral* ligaments (*Lig. intervertebralia*) are the principal means of uniting the bodies of the vertebræ, and the vertebræ generally; for the attachments of these bones in other parts, are much looser and much less extensive.

These ligaments completely fill the spaces between the bodies of the vertebræ; they form layers, the upper and lower faces of which are attached to the corresponding faces of two superimposed vertebræ.

They are formed of a considerale number of perpendicular and almost concentric layers, shaped like the circumference of the upper and lower faces of the vertebræ, and they are consequently annular. Their two edges are attached to the two faces of the vertebræ. Their layers are evidently fibrous; in the external layers the fibres are oblique, and almost horizontal in the internal. The oblique fibres of the external layers cross at acute angles. The layers adhere very firmly together by the fibres which extend from one to the other; hence they form only a single dense scaly tissue.

Between the layers we find a softer, yellowish, gelatinous, and shapeless mass.

The nature, the relations, and the proportional quantity of these two substances, differ in all parts of the ligament.

In the circumference, and especially in its anterior portion, the layers much exceed the intermediate substance; they are very compact and are evidently fibrous. Internally, they are much softer; they separate from each other and finally disappear entirely, so that the nucleus, formed by the gelatinous substance, only remains. In what-

ever direction the vertebral ligaments are cut, this nucleus projects from the incision, being pushed out by the elasticity of the fibrous layers.

These ligaments are thicker in the centre than on the circumference, because the bodies of the vertebræ are concave in this place.

They are very solid, so that the bones of the vertebral column will break before they tear.

From their great elasticity, the height of man varies at all periods of life, and diminishes or increases according as the vertebral ligaments have been for a longer or shorter time pressed down by the weight of the head and that of the vertebræ upon each other; hence man is taller in the morning than at night. This difference is not the same at all ages; it is less evident in old than in young men. In general it amounts to about one inch.*

The intervertebral ligaments have not the same thickness in all parts. It diminishes from the cervical vertebræ to the lower extremity of the vertebral column, whence there is a difference in this respect of several lines. Between the lumbar, these ligaments are only three or four lines thick.

§ 824. There are no intervertebral ligaments between the first and second cervical vertebræ, nor between the first and the head, between the sacrum and the coccyx, nor between the bones of the coccyx; these bones are united in a looser manner.

§ 825. The intervertebral ligaments are strengthened directly by anterior and posterior vertebral ligaments (§ 822, 823), which cover most of their circumference, and pass before them in going from one vertebra to another.

II. OF THE FIBROUS AND FIBRO-CARTILAGINOUS LIGAMENTS BETWEEN THE ARCHES AND THE PROCESSES.

A. YELLOW LIGAMENTS.

§ 826. The arches of the vertebræ are united by the *yellow* ligaments (*Lig. crurum vel arcuum subfla*, s. *flava*), as their bodies are connected by the intervertebral ligaments. These two kinds of ligaments may then be compared to each other.

The yellow ligaments are yellowish, lustreless, and smooth; they are formed of several perpendicular and very elastic fibres, of which the external are evidently of a tendinous nature. These external fibres, which have a more oblique direction, fill all the space between the arches of two adjacent vertebræ, from the roots of the transverse processes to the angle of union, which however remains unattached.

Their upper edge is always attached to the internal face, and never to the inferior edge of the arch of the vertebra above. The inferior is attached to the upper edge, and slightly to the external face of the

* *Mém. de Paris*, 1725. 1730.

arch of the vertebra below. The vertebræ are rough where these ligaments are inserted.

The thickness, solidity, and elasticity of these ligaments are very considerable.

They fix the extent of flexion forward and backward in the vertebral column.

They are not perfectly similar in all parts of the spinal column. The smallest are in the dorsal region, those in the neck are larger, and the largest in the lumbar region. Those in the lumbar region are the thickest, and the thinnest are those of the cervical region. Their insertions also vary in extent in the different regions ; in the neck they are attached by a thin upper edge to a very narrow portion of the internal face of their arches, above their inferior edge. In the back and loins, this portion is a very broad surface, almost as high as the ligaments, and extends from the centre of the arches to their inferior edge.* These differences are worthy of remark, first, because anatomists have hitherto neglected the second ; secondly, because they serve to increase the power of the lower portions of the vertebral column and the mobility of its upper portions.

The yellow ligaments do not exist between the first and the second cervical vertebræ, nor between the first cervical vertebra and the occipital bone, or at least they are developed very feebly in these two parts.

B. INTERSPINAL MEMBRANES AND SUPRASPINAL LIGAMENTS.

§ 827. Between the spinous processes we find two kinds of fibrous ligaments, the *interspinal membranes* (*membranæ interspinales*), and the *supraspinal* ligaments (*Lig. inter apices processuum spinosorum*).

a. Interspinal membranes.

§ 828. The *interspinal membranes* are thin and broad, and are formed of irregular, and generally of horizontal fibres. They extend from the roots of the spinous processes to near their summits. They limit flexion forward and are destined especially for the insertion of the long muscles of the back.

b. Supraspinal ligaments.

§ 829. The *supraspinal* ligaments are small rounded bundles of longitudinal fibres, which attach the summits of the spinous processes of the vertebræ to each other, so as to form in fact but one ligament. They also serve to limit flexion forward.

* Weitbrecht is mistaken in saying of these ligaments (*loc. cit.* page 107), *Maximes prædictorum erurum vix sensibiliter superscandunt*, since they are everywhere attached much higher than the lower edge, and none of their fibres are inserted in the vertebræ of the neck.

C. INTERTRANSVERSE LIGAMENTS.

§ 830. The *intertransverse* ligaments (*Lig. recta processuum transversalium vertebrarum*, s. *intertransversaria*) do not everywhere exist. They are found only between the transverse processes of the inferior dorsal vertebræ forward. They serve not so much to unite the vertebræ as to multiply the points of attachment for the sacro-lumbalis and the levatores costarum muscles.

II. CAPSULAR LIGAMENTS.

§ 831. We find on each side, between every two vertebræ, a *capsular* ligament, the ligament of the *articular processes* (*Lig. capsulare processuum obliquorum*); this arises from the circumference of the articular faces of the adjacent oblique processes by irregular bundles of fibres. In the dorsal and lumbar regions this ligament is strengthened anteriorly by the yellow ligaments.

These ligaments have not the same extent in every part. They are much looser and less tense in the neck than in the other parts of the vertebral column. The broadest, the thinnest, and the loosest, is that between the first and second cervical vertebræ.

CHAPTER II.

OF THE LIGAMENTS OF THE RIBS.

§ 832. The ligaments of the ribs are divided into three classes:—
1st. Those situated between the ribs and the vertebræ.
2d. Those situated between the ribs and the sternum.
3d. Those which exist between the ribs.

I. LIGAMENTS BETWEEN THE RIBS AND THE VERTEBRÆ.

§ 833. The ligaments between the ribs and the vertebræ, are some of them synovial capsules, and others supplementary fibres, which unite the posterior parts of the ribs with the bodies and the transverse processes of the vertebræ.

A. LIGAMENTS OF THE HEADS OF THE RIBS.

§ 834. The ligaments of the heads of the ribs (*Lig. capitulorum costarum*) are short capsules, which extend from the lateral articular facets of the dorsal vertebræ to the heads of the ribs. These capsules are strengthened in front by the oblique fibrous ligaments, which have two different directions; the upper go from within outward, and from above downward, and the inferior in the opposite direction.

B. LIGAMENTS OF THE TUBERCLE, AND THE EXTERNAL TRANSVERSE LIGAMENTS OF THE RIBS.

§ 835. Short synovial capsules arise from the anterior face of the summits of the transverse processes of the dorsal vertebræ, and go to the circumference of the articular surface of the tubercles. These capsules are looser in the lower than in the upper ribs,

The *quadrangular ligaments* (*ligamenta transversaria costarum externa*) are situated on them posteriorly, and proceed from the summits of the transverse processes of the vertebræ; they are formed of very strong, more or less transverse fibres. These ligaments are narrower from above downward than from without inward, and are longer in the inferior than in the superior vertebræ. Their fibres descend to the upper and ascend to the lower ribs, from the transverse processes of the vertebræ.

They serve to strengthen the articulations of the ribs with the vertebræ.

C. INTERNAL LIGAMENTS OF THE NECKS OF THE RIBS.

§ 837. The *internal ligaments of the necks of the ribs*, or the *internal transverse ligaments* (*Lig. cervicis costarum interna*, s. *transversaria interna*) do not extend, like the former, from the vertebræ to the ribs, which are articulated with them; but from the inferior edge of the transverse process of the vertebra above, to the neck of the rib below. They are formed of fibres which proceed obliquely from above downward, and from within inward. Their form is rhomboidal, and they are thinner and more feeble than the former.

D. EXTERNAL LIGAMENTS OF THE NECKS OF THE RIBS.

§ 837. The *external ligaments of the necks of the ribs* (*Lig. costarum cervicis externa*) are situated opposite the internal, and are composed of fibres, which proceed in an opposite direction, and also extend from the transverse processes of the vertebræ to the necks of the ribs next below. They are scarcely apparent, or in fact do not exist, between the two upper and the two lower ribs.

E. ACCESSORY LIGAMENTS OF THE RIBS.

§ 838. The *accessory ligaments of the ribs* (*Lig. accessoria costarum*) are rounded bands situated beyond the articular heads, which descend from the transverse processes of the vertebræ to the posterior extremities of the bodies of the ribs.

II. COSTO-STERNAL LIGAMENTS.

§ 839. The ribs unite to the sternum by the costal cartilages, in part directly, in part indirectly.

The cartilage of the first rib is attached to the handle of the sternum, and those of the other six true ribs unite to the articular depressions of this bone by very short capsular ligaments, on which pass strong tendinous fibres united to the periosteum. These ligaments radiate and extend very far, particularly on the anterior face of the body, so that those of one side intercross with those of the side opposite.

III. INTERCOSTAL LIGAMENTS.

§ 840. If we except some tendinous fasciculi of the intercostal muscles which are situated between the bony portions of two adjacent ribs, and which are continuous posteriorly with the intertransverse ligaments of the vertebræ (§ 830), only the costal cartilages are united by particular and constant ligaments. These ligaments are arranged in two different ways.

A. ARTICULAR LIGAMENTS OF THE COSTAL CARTILAGES.

§ 841. The fifth, sixth, seventh, and eighth costal cartilages are united by synovial capsules, on which are strong fibres passing obliquely from above downward, and from without inward. Instead of these capsules, we find between the two following ribs only short tendinous fibres; and between the last ribs only the fibres of the intercostal muscles, and of the obliqui abdominis muscles.

B. FIBROUS LIGAMENTS OF THE COSTAL CARTILAGES.

§ 842. Narrower fibrous ligaments (*Lig. coruscantia*) are situated perpendicularly or obliquel from above downward, and from without inward. They proceed forward, rarely backward, and unite together the costal cartilages, beginning with that of the third rib, except those of the four mentioned in the paragraph above.

CHAPTER III.

OF THE LIGAMENTS OF THE STERNUM.

§ 844. Between the three pieces of the sternum is a fibro-cartilaginous mass formed of horizontal fibres, which go from before backward. This mass seldom disappears entirely, and never except at a very advanced age; but it is effaced between the second and the third pieces more frequently than between the first and second. It may be compared with the intervertebral cartilages (§ 823).

On its surface, and also on the anterior and the posterior face of the sternum, are expanded firm tendinous bands, which unite to form membranous expansions termed the *anterior* and *posterior sternal membranes* (*membrana ossium sterni anterior et posterior*).

The *posterior sternal membrane* is formed almost entirely of perpendicular fibres, which are connected with the fibrous bands coming from the membrane of the costal cartilages, at the place where the latter unite to the sternum.

In the *anterior sternal membrane*, on the contrary, we see only at its inferior portion and on the median line, a narrow band formed of longitudinal fibres which arise from the fibres of the membrane of the cartilages of the inferior true ribs. Most of its fibres are formed of fan-like expansions, the summits of which correspond to the insertions of the costal cartilages in the sternum, and intercross with those of the posterior face of the sternum, partially covering the longitudinal fibres from the same origin, and partly covered by them.

These two sternal membranes evidently correspond to the two ligaments of the vertebral column (§ 821, 822). They should then, from analogy be called the sternal ligaments.

SECTION II.

OF THE LIGAMENTS OF THE HEAD.

§ 844. The *ligaments of the head* are—
1st. The ligaments which unite the head to the vertebral column.
2d. The ligaments of the lower maxillary bone.

CHAPTER I.

OF THE LIGAMENTS BETWEEN THE HEAD AND THE VERTEBRAL COLUMN.*

§ 845. The head, and particularly the occipital bone, considered as a single bone articulated to the vertebral column, unites with the first and second cervical vertebræ, and with each differently. The peculiarities of the articulations between the first and second cervical vertebræ, have determined us to examine them separately, and to describe them apart from the general ligaments of the vertebral column.

I. LIGAMENTS BETWEEN THE OCCIPITAL BONE AND THE ATLAS.

§ 846. The connection between the occipital bone and the atlas is less intimate than between the vertebræ. The intervertebral and the yellow ligaments do not exist; they are, like the fibrous ligaments, replaced only by looser fibrous bands, which extend from the anterior and posterior arches to the large occipital foramen, and are called the *occipito atloidal membranes.*

* Mauchart, resp. Rumelin, *Capitis articulatio cum primâ et secundâ colli vertebrâ*, Tubingen, 1717.

I. ANTERIOR OCCIPITO-ATLOIDAL MEMBRANE.

§ 847. The *anterior occipito-atloidal* ligament (*membrana annuli anterioris atlantis*) is, in fact, only the summit of the anterior vertebral ligament, and extends from the anterior arch of the atlas to the anterior edge of the large occipital foramen. It is formed of perpendicular fibres, of which those in the centre are stronger, and form a distinct and projecting fasciculus, which is continuous with the central and prominent portion of the anterior vertebral ligament (§ 821) and is attached to the centre of the basilar process of the occipital bone.

II. POSTERIOR OCCIPITO-ATLOIDAL MEMBRANE.

§ 848. The *posterior occipito-atloidal membrane* (*membrana annuli posterioris atlantis*) is situated between the posterior extremities of the two articular ligaments, and extends from the upper edge of the posterior arch to the posterior part of the circumference of the occipital foramen, and fills the posterior space between the two bones. It is thinner and weaker than the anterior, and does not form a continuous membrane, as that does.

III. ARTICULAR LIGAMENTS.

§ 849. The articular processes of the occipital bone and of the atlas are united, like the articular surfaces of the transverse processes, by a complete capsular ligament (*Lig. articulationum capitis cum atlante, Lig. articulare superius*), which arises from the circumference of their contiguous surfaces. It differs from the others in being broader and looser, so that it allows more extensive motions.

IV. ACCESSORY LIGAMENTS.

§ 850. The *accessory* ligaments (*Lig. accessoria*) are fibrous bands, which proceed obliquely from above downward, and from without inward, from the summit and from the upper edge of the transverse processes of the atlas, and are attached partly to the capsule and partly to the occipito-atloidal membranes, and around the occipital foramen. They strengthen the ligaments already described, and furnish points of attachment to the small deep muscles of the head.

II. LIGAMENTS BETWEEN THE BASILAR BONE AND THE AXIS.

§ 851. The union between the head and the axis by means of the basilar bone is much firmer and stronger than that between the head and the atlas. It is formed by very dense bands of longitudinal fibres, which extend from the edges of the occipital foramen to the centre of the axis. There are no capsular ligaments in this articulation.

I. SUSPENSORY LIGAMENT OF THE SECOND CERVICAL VERTEBRA.

§ 852. The *middle straight* ligament, or the *suspensory ligament* of the second cervical vertebra* (*Lig. suspensorium dentis epistrophæi*, s. *rectum medium*), is oblong and composed of straight fibres. It extends from the centre of the anterior edge of the occipital foramen to the summit of the odontoid process, to which it is attached directly above the small anterior articular fossa. It prevents the head from turning too far backward.

II. LATERAL LIGAMENTS OF THE SECOND CERVICAL VERTEBRA.

§ 853. The *lateral* ligaments of the second cervical vertebra (*Lig. epistrophæi lateralia*, s. *alaria Maucharti*) are one on each side, and arise some lines behind the suspensory ligament, from the anterior part of the lateral region of the occipital foramen, and from the rough fossa situated above the internal edge of the condyles of the occipital bone. Their fibres are oblique and are attached to the lateral edges of the odontoid process.

When the head is turned to one side the fibres of the lateral ligament of the opposite side are tense; so that these ligaments limit the lateral motions of the head.

These three ligaments are the most important of those which unite the head with the first cervical vertebra. If one or all three of them be torn, the odontoid process is displaced by the least exertion, slips into the vertebral canal, suddenly compresses the origin of the spinal marrow, and thus occasions death. Hence death from hanging, and hence, too, when the head is quickly turned to the side, or when it executes similar motions, the subject sometimes dies.

III. COMMON LIGAMENTS BETWEEN THE BASILAR BONE AND THE CERVICAL VERTEBRÆ.

§ 854. The common ligaments between the basilar bone and the cervical vertebræ are of several kinds, and differ in form, situation, and

* Sœmmerring (*Bandlehre*, p. 17) has already remarked that Weitbrecht was wrong in denying the existence of this ligament. In fact, we have always found it perfectly distinct from the crucial ligament; so that we cannot agree with Weitbrecht in thinking that anatomists have been induced by this branch to admit its existence, since we have found both of them constantly, and they were separated by loose cellular tissue. This remark might seem superfluous, if Bichat had not adopted Weitbrecht's opinion. True, he describes a special ligament between the ridge of the odontoid process and the basilar bone, but he is mistaken in stating it to be formed by the upper branch of the crucial ligament and the suspensory ligament; so that he describes the crucial ligament as formed only of a transverse part and the lower branch, and even mentions a connection between its fibres and those of the posterior ligaments of the vertebræ, although in fact they are separated by the capsule of the crucial ligament (§ 857).

extent. We may divide them into those which are situated *within* and those which are placed on the *outside* of the vertebral column.

I. COMMON INTERNAL LIGAMENTS.

A. CRUCIAL LIGAMENT.

§ 855. Behind the ligament described we find another, which is weaker, called the *crucial* ligament (*Lig. cruciform*). It is also called the *transverse ligament of the atlas* (*L. atlantis transversale*); this term is, however, improper, as it points out only one of its parts. It unites the basilar bone with the first two cervical vertebræ.

Its strongest transverse part, called the *transverse ligament of the atlas*, is formed of transverse fibres. It is attached by its two extremities to the rough lateral edge of the medullary foramen of the atlas. It is very tense, and is situated behind the odontoid process: it is much broader in the centre than at its two extremities, and it is cartilaginous forward on the side of the posterior face of the odontoid process. Mauchat has noticed this peculiarity, but he adds, that in this part the ligament does not adhere to the process but is only in contact with it. Bichat only has described the connection of this cartilaginous portion with the process; he states that a synovial capsule exists between them. In fact, we have constantly observed this capsule, which we have always found also very broad and very loose.

This transverse ligament forms the two horizontal branches of the cross. The two perpendicular branches of the cross, the upper and the lower, called also the *appendages* (*appendices*), arise from its centre; these are much weaker and are both formed of longitudinal fibres.

The *upper* branch is much longer than the lower, becomes much broader upward, and is not only attached behind the suspensary ligament, from which it is evidently distinct at the centre of the occipital foramen, but also extends some lines on the centre of the upper face of the basilar process of the occipital bone.

The *inferior* branch is much shorter than the other, and it is attached directly below the posterior articular facet of the odontoid process, which is smooth and not cartilaginous, to the upper part of the posterior edge of its base, which is considerably rough.

The use of this ligament is not merely to strengthen the connections between the three bones to which it is attached, but also to allow the atlas to rotate around the odontoid process as around an axis, in which the synovial capsule assists and at the same time to protect the spinal marrow from the action of this process.

B. LIGAMENTOUS ENVELOP OF THE HEAD AND CERVICAL VERTEBRÆ.

§ 856. Behind the crucial ligament, between it and the posterior ligament of the vertebral column to which it is loosely attached, we

find a broad layer of longitudinal fibres, which arises from the upper face of the basilar process of the occipital bone and descends to the third or fourth cervical vertebra. This layer unites above with the dura-mater and below with the posterior bridge of the vertebræ. It is called the *ligamentous envelop of the cervical vertebræ* (*apparatus vertebrarum colli ligamentosus*).

II. COMMON EXTERNAL LIGAMENT BETWEEN THE HEAD AND THE CERVICAL VERTEBRÆ.

§ 857. The common external ligament between the head and the cervical vertebræ is the *cervical* ligament (*Lig. nuchæ*, s. *cervicis*), which begins at the spinous process of the seventh cervical vertebræ, whence it extends to the posterior occipital spine and to its upper curved line. This ligament is thin and perpendicular, and gradually enlarges as it approaches the head. Its upper edge is thicker, it being formed of the united tendons of the muscles of the neck. It is continuous between the cervical vertebræ with the interspinal ligaments, and its posterior edge represents the supraspinal ligaments.

VI. LIGAMENTS BETWEEN THE FIRST AND SECOND CERVICAL VERETBRÆ.

§ 858. Beside the posterior ligament and the two common capsular ligaments, which are looser here than in the rest of the vertebral column, the anterior face of the odontoid process unites also with the centre of the posterior face of the anterior arch of the atlas by a loose capsular ligament.

CHAPTER II.

OF THE LIGAMENTS OF THE LOWER MAXILLARY BONE.

§ 859. The *ligaments of the lower maxillary bone* are, 1st, those which unite it with the temporal bones; and, 2d, those between it and the hyoid bones.

I. LIGAMENTS OF THE TEMPORO-MAXILLARY ARTICULATION.

§ 860. The temporo-maxillary articulation is formed by an *interarticular cartilage*, two *synovial capsules*, and by accessory *fibrous ligaments*.

1. INTERARTICULAR CARTILAGE AND SYNOVIAL CAPSULES.

A. INTERARTICULAR CARTILAGE.

§ 861. The *interarticular cartilage* (*operculum cartilagineum*) belongs to the class of fibro-cartilages: it is oval, situated horizontally

with concave surfaces, and much thinner in its centre than at the edges. There is often in its centre a cavity filled by synovial membranes, which are then directly united. Its circumference is attached only to these membranes, and its external edge slightly adheres to the fibrous ligaments.

This fibro-cartilage diminishes the friction between the articular surfaces of the two bones.

B. SYNOVIAL CAPSULES.

§ 862. One of the two synovial capsules (*ligamenta cartilaginis intermediæ*) is situated above and the other below the interarticular cartilage.

The *superior synovial capsule* arises from the anterior edge of the transverse articular tubercle and from the posterior edge of the articular cavity of the temporal bone, and is attached to the circumference of the interarticular cartilage. It unites above with the cartilaginous covering of the articular surface of the temporal bone, and below with the upper face of the interarticular cartilage.

The *inferior* arises from the circumference of the maxillary condyle, and is attached to the edge of the interarticular cartilage, and unites partly with this cartilage and partly with the cartilage of the maxillary condyle.

These two capsules are very loose, and permit very extensive motions, especially upward and downward, since they are not confined forward or backward by fibrous ligaments.

II. FIBROUS LIGAMENTS.

§ 863. The firmness of the temporo-maxillary articulation depends on an external and an internal fibrous ligament.

A. EXTERNAL FIBROUS LIGAMENT.

§ 864. The *external fibrous* ligament (*membranæ maxilla inferioris*) consists of very firm longitudinal fibres, which arise from the posterior extremity of the zygomatic process of the temporal bone, descend to the neck of the lower maxillary bone, and are attached to the outside and partly to the posterior part of the circumference of the synovial capsule. It is very tense when the jaw is moved forcibly forward or backward, so that it limits these two motions.

B. INTERNAL LATERAL LIGAMENT.

§ 865. The *internal lateral* ligament (*Lig. maxillæ laterale*) should not be considered, properly speaking, as belonging to the temporo-max-

illary articulation; for it is situated at some distance from it and adds nothing to its firmness.

It is a thin, oblong, tendinous layer, arises from the spine of the sphenoid bone, and descends obliquely from above downward, from behind forward, and from within outward, to the lower maxillary bone where it is attached below the internal orifice of the dental canal.

The vessels and the nerves of the lower maxillary bone pass between this ligament and its neck. Its principal use is, to enlarge those surfaces to which the two pterygoid muscles are attached, the outer part of which arises from them, and it is situated between their outer extremities.

II. LIGAMENTS BETWEEN THE SKULL, THE LOWER MAXILLARY BONE AND THE HYOID BONE.

§ 866. In nearly the same direction as the ligament already described, but more deeply situated, we find a membrane which is thinner, slightly tense, and formed by condensed cellular tissue: this is strengthened only by some fibrous bands, which extend from the lower extremity of the styloid process of the temporal bone to the posterior edge of the angle of the jaw, and send a cylindrical slip to the small horn of the hyoid bone. This is the *stylo-mylo-hyoid* ligament (*Lig. stylo-mylo-hyoideum*): it serves partly to unite the temporal, the inferior maxillary and the hyoid bones, and partly to enlarge the surface to which the pterygoideus internus muscle is attached.

CHAPTER III.

OF THE LIGAMENTS OF THE HYOID BONES

§ 867. The body or the central portion of the hyoid bone articulates with the large and small horns by two synovial capsules; one of them is narrow and tight and the second is broad and loose. Both, but the first particularly, are strengthened by tendinous fibres.

The posterior extremity of the large horn is attached to the superior horn of the thyroid cartilage by a round perpendicular ligament in the centre of which we often find a round cartilage or bone.

SECTION III.

OF THE LIGAMENTS OF THE EXTREMITIES.

CHAPTER I.

OF THE LIGAMENTS OF THE UPPER EXTREMITIES.

§ 868. The ligaments of the upper extremities are—
1st. Those between the trunk and the upper extremities.
2d. Those of the scapula.
3d. Those of the elbow-joint.
4th. Those of the fore-arm.
5th. Those of the wrist-joint.
6th. Those of the fingers.

ARTICLE FIRST.

LIGAMENTS BETWEEN THE TRUNK AND THE UPPER EXTREMITIES.

§ 869. The upper extremities are attached to the anterior and superior part of the trunk by the clavicles, to which they are united by synovial and fibrous ligaments. The scapula, trunk, and head, are united only by muscles.

The clavicle is articulated, by its anterior extremity, with the clavicle of the opposite side, and also with the first piece of the sternum and the first rib.

I. INTERCLAVICULAR LIGAMENT.

§ 870. The *interclavicular* ligament (*Lig. interclaviculare, transversum*) is thin and formed of transverse fibres. Its upper edge is loose and concave; the inferior is straight or slightly convex, and is mostly attached to the upper part of the handle of the sternum. It extends from the upper extremity of the articular surface of the internal edge of one clavicle to the corresponding part of the opposite clavicle; so that it unites these bones with each other and with the sternum, and prevents them from moving too far backward.

II. STERNO-CLAVICULAR ARTICULATION.

§ 871. The clavicle and sternum are connected by an *interarticular cartilage, two synovial capsules,* and a *fibrous ligament.*

A. INTERARTICULAR CARTILAGE.

§ 872. The *interarticular cartilage* is generally very soft, almost membranous, extremely thin in its centre, and, on the contrary, very thick in its circumference, so that its two faces are concave. It is attached downward, backward, and inward, by a thick and firm fibro-cartilaginous tissue to the facet where the clavicle unites with the sternum; downward and forward to the clavicle, and to the inner part of the cartilage of the first rib; upward, forward, and outward, to the margin of the articular facet of the clavicle. It unites intimately forward and backward, with the fibrous ligaments of the sterno-clavicular articulation. It is firmly attached, and admits of but little motion on account of the thickness and breadth of that part of the cartilage which is external to the synovial capsules.

B. SYNOVIAL CAPSULES.

§ 873. The synovial capsules are two, an *upper* and *external*, and a *lower* and *internal*.

The *upper* arises from the margin of the anterior part of the anterior articular facet of the clavicle, which is smooth and covered with cartilage, and is attached around the upper face of the thin and internal part of the interarticular cartilage.

The *lower* arises from the upper part of the lower face of this cartilage, and is attached to the anterior, inferior, and external portion of the articular facet of the handle of the sternum.

Both are small and narrow.

C. FIBROUS LIGAMENTS.

§ 874. The synovial capsules are strengthened by fibrous ligaments which are attached principally to the anterior and posterior parts of their circumference, but never form a dense layer.

The *anterior fibrous* ligament is the stronger, and is formed by perpendicular descending fibres. The *posterior* is formed of radiated fibres, which are attached partly to the posterior face of the upper part of the handle of the sternum and partly to the cartilage of the first rib, and are united with the anterior and the posterior periosteum of the sternum.

I. OF THE COSTO-CLAVICULAR LIGAMENT, OR THE RHOMBOID LIGAMENT.

§ 875. The space between the sternal extremity of the clavicle, the anterior extremity of the rib and most of its cartilage, is filled by a ligament formed of oblique intercrossing fibres: this arises from the posterior edge of the clavicle, goes obliquely from above downward, and from behind forward, and is inserted in the upper and posterior

edge of the rib and of its cartilage. A band of transverse fibres is often detached from its inner and inferior extremity, which goes to the lower external extremity of the articular facet of the handle to which the clavicle is attached. It is called the *rhomboid* ligament (*Lig. rhomboideum*), from its form. It unites the bones to which it is attached, retains the clavicle and the first rib in their places, and increases the number of points of attachment of the subclavian muscle.

ARTICLE SECOND.

OF THE LIGAMENTS OF THE SCAPULA.

§ 876. Some of the ligaments of the scapula unite this bone with the clavicle, and others directly or indirectly with the humerus.

I. OF THE LIGAMENTS BETWEEN THE SCAPULA AND THE CLAVICLE.

§ 877. The clavicle and scapula are united by a capsular ligament and by several fibrous ligaments.

A. ACROMIO-CLAVICULAR LIGAMENT.

§ 878. A *capsular* ligament (*connexio claviculæ cum acromio*) unites the acromion process of the scapula with the humeral edge of the clavicle. We may then term it the *acromio-clavicular* ligament (*Lig. acromio-claviculare*). It is short, very tense, and sometimes double, when an inter-articular cartilage exists between these two bones: this articular cartilage, however, is *not* constant, and often fuses with them completely.

Very solid and transverse fibres go upward and downward, but especially upward, over this ligament, which are attached also to the circumference of the inter-articular cartilage.

B. CORACO-CLAVICULAR LIGAMENT.

§ 879. The fibrous ligaments are generally two, which are also known as the common ligaments of the scapula, and both unite the clavicle with the coracoid process of the scapula. We cannot however deny that it would be more convenient to consider them simply as two bands of the same ligament, the fibres of which have not the same direction; one of them is external, the other internal, and they are uninterruptedly continuous with each other. This ligament is called the *coraco-clavicular* ligament (*Lig. coraco-clavicular*), to distinguish it from the preceding, and is formed by strong thick fibres.

It arises from the outer half of the upper face of the coracoid process, and is composed of ascending fibres. It is attached by its upper ex-

tremity to the inferior face, and to the posterior edge of the scapular extremity of the clavicle, but it does not extend to the outer end of this bone.

The internal and posterior fibres are shorter and more perpendicular: the anterior and external are longer and more oblique.

The two bands which form this ligament are commonly described, the inner as the *common conoid* ligament, and the external as the *common trapezoid* ligament of the scapula (*Lig. scapulæ communia conoides et trapezoides*).

The *conoid* ligament arises from the root of the coracoid process, proceeds more from before backward, and is attached to the posterior edge of the clavicle: its blunt summit corresponds to the coracoid process, and its broader base to the clavicle. Its anterior fibres are shorter and more perpendicular than the posterior.

The *trapezoid* ligament arises from about the centre of the upper part of the coracoid process; its direction is more transverse, and it is attached more externally than the preceding, to the inferior face of the scapular extremity of the clavicle. The anterior are longer than the posterior fibres.

II. OF THE LIGAMENTS BETWEEN DIFFERENT PARTS OF THE SCAPULA, OR OF ITS PROPER LIGAMENTS.

§ 880. The proper ligaments of the scapula are simply fibrous, and extend, like a bridge, between the two eminences of this bone.

A. ACROMIO-CORACOID LIGAMENT.

§ 881. The *acromio-coracoid* ligament (*Lig. coraco-acromiale*, s. *interius*, *majus*, *triquetrum*) is a thin band formed of horizontal fibres, which converge from before backward. It sometimes arises by two separate bundles from the whole posterior edge of the coracoid process, and is attached to the anterior extremity of the acromion process. It gradually contracts from before backward, and from within outward, and terminates in a very acute summit. The inner and outer edges (the former of which is the longer) are loose. The whole ligament is covered by the scapular extremity of the clavicle, and by the deltoid muscle, rests on the anterior part of the supra-spinatus muscle which keeps it in place, and terminates by a thick layer placed under the deltoid muscle; it projects over the scapulo-humeral articulation, and thus prevents the displacement of the humerus upward.

B. COSTO-CORACOID LIGAMENT.

§ 882. The *costo-coracoid* ligament (*Lig. coraco-costoideum*), called also the *coracoid* (*Lig. coracoideum*) or the *proper small* ligament of

the scapula (*Lig. scapulæ proprium, posterius, minus, obliquum*), is much smaller than the preceding; it has the form of a thin square band, and it extends from the root of the coracoid process to the inner end of the upper edge of the scapula, or of the rib above the scapular fissure, which it changes into a canal through which the nerves and vessels of the shoulder pass. It often ossifies.

III. HUMERO-SCAPULAR ARTICULATION.

§ 883. The *humero-scapular articulation* is formed by a synovial capsule and a fibrous capsule, which covers the former. These two capsules are called the *large capsular* ligament of the humerus (*Lig. capsulare ossis humeri magnum*).

A. SYNOVIAL CAPSULES.

§ 884. The *synovial capsule* covers the articular surface of the scapula above, and the head of the humerus below. After leaving these two surfaces, it reflects on itself to form a large and loose sac.

This sac, like all the synovial capsules, is entirely closed; but it covers also the bicipital groove, and even the upper part of the tendon of the long portion of the biceps muscle, for it is reflected from the groove over the tendon, although no opening exists on this part.

B. FIBROUS CAPSULE.

§ 885. All the surface of this synovial capsule is covered by a complete fibrous capsule, which forms a broad and loose sac, open on the two sides. It is attached above to the circumference of the glenoid cavity of the scapula, and below to the neck of the humerus: in both points it is continuous with the periosteum.

Its upper edge is continuous with a fibro-cartilaginous ring, which surrounds the glenoid cavity, and slightly projects above its surface. It is called the *glenoid* ligament (*Lig. glenoideum*). It is formed of closely interlaced fibres, and is thicker at its upper portion than in its other parts, since it is there strengthened by a fibrous band coming from the coracoid process. Its internal face is thinner, and even there we occasionally see spaces filled by the tendon of the subscapularis muscle.

It is strengthened above by the tendon of the supra-spinatus muscle, backward by that of the infra-spinatus muscle and of the teres minor muscle.

Below and forward its internal edge presents a slight opening, through which the long tendon of the biceps flexor muscle passes.

The looseness of this ligament allows great freedom of motion in the upper extremities.

ARTICLE THIRD.

OF THE LIGAMENTS OF THE ELBOW-JOINT.

§ 886. We find at the articulation of the elbow a *synovial capsule* and several *fibrous ligaments.*

I. SYNOVIAL CAPSULE.

§ 887. The *synovial capsule* (*membrana cubiti capsularis*) unites the lower extremity of the humerus and the upper extremities of the ulna and radius.

Above, after covering the cartilaginous articular surface of the lower extremity of the humerus with which it is blended, it detaches itself forward from the upper part of the two anterior articular cavities; on the sides from the base of the two condyles along the posterior cartilaginous edges of the pulley and of the lower head; backward from the upper part of the posterior articular cavity. From these different points it goes toward the radius and ulna, to which its inferior edge is attached. It is much looser and more extensive than on the sides.

The portion attached to the radius descends deeply below the head of this bone to the commencement of its neck; so that the head, enveloped by the reflected portion of the synovial capsule, is loose and enclosed in its cavity.

From the inferior part of the neck of the radius it goes on the anterior side of the upper extremity of the ulna; there it lines the lateral sigmoid cavities, and the upper edge of the condyle and the coronoid process of the ulna.

We find considerable masses of articular fat in many places, but principally in the anterior and posterior articular cavities, especially above the pulley, between the heads of the radius and ulna, and within the large upper sigmoid cavity; consequently, in all those parts most exposed to compression and friction.

From this description it follows that this synovial capsule, between the anterior part of the articular face of the humerus and that of the radius, is much looser than between the posterior and that of the ulna, which is owing to the greater extent of motion of the radius; for the radius rotates on its axis, while the ulna has only the motions of flexion and extension.

II. FIBROUS LIGAMENTS.

§ 888. The synovial capsule of the elbow-joint is strengthened, on its anterior and posterior faces and on the sides, by fibrous bands, which may be considered so many distinct ligaments, the *lateral*, the *anterior* and the *posterior.*

The two lateral ligaments are oblong and formed of longitudinal fibres.

I. INTERNAL LATERAL LIGAMENT.

§ 889. The *internal lateral* ligament (*Lig. cubiti laterale internium*), arises from the inner part of the anterior face of the internal condyle of the humerus, covers the internal part of the synovial capsule, and is attached below to the internal edge of the coronoid process of the ulna.

II. EXTERNAL LATERAL LIGAMENT.

§ 890. The *external lateral* ligament (*Lig. cubiti laterale externum*) extends from the anterior face of the external condyle to the inner portion of the circumference of the head of the radius.

III. ANTERIOR AND POSTERIOR LIGAMENTS.

§ 891. The *anterior and posterior fibrous* ligaments (*Lig. cubiti anterius et posterius*) are formed of less regular fibres, and they are broader but weaker than the lateral ligaments.

The *anterior* is strongest in its centre. It is formed of longitudinal fibres, which are loose at its upper part, oblique in the centre, and more transverse in the lower part.

The *posterior* is not well marked, except on the sides, where it is strongest and composed of bands which converge downward; in other parts it is hardly seen.

ARTICLE FOURTH.

OF THE LIGAMENTS OF THE BONES OF THE FORE-ARM.

§ 892. The bones of the fore-arm are united in most of their length but not in the same manner, nor do the agents of union form a continuous whole. We find at the upper part two fibrous ligaments, in the centre a fibrous ligament, and below a synovial capsule.

I. SUPERIOR REGION.

I. ANNULAR LIGAMENT.

§ 893. The *annular* ligament of the radius (*Lig. radii annulare*) is very strong, and arises from the anterior and posterior extremities of the lateral sigmoid articular cavity of the ulna. It is formed of horizontal and circular fibres, and loosely surrounds the neck of the radius. Behind the sigmoid cavity it forms a circle, lined by the synovial membrane

of the elbow-joint, in which the head and the neck of the radius move. Its fibres interlace above with those of the anterior, posterior, and external lateral ligaments; but it terminates downward in a loose edge.

This ligament strengthens the synovial capsule; it confines the motions of the upper part of the radius and keeps it in place.

II. ROUND LIGAMENT.

§ 894. The *round* or *oblique* ligament, called also, but very improperly, the *transverse* ligament (*Lig. antibrachii*, s. *cubit teres*, s. *membrana obliqua*, s. *transversa*), is a thin but strong band, broadest at its upper part, situated on the anterior face of the bones of the fore-arm: it descends obliquely from the tubercle of the ulna to the internal face of the radius, and is attached below its tubercle.

Its uses are to limit the motion of supination in the radius.

II. MIDDLE REGION.

INTEROSSEOUS LIGAMENT.

§ 893. The *interosseous* ligament (*Lig.*, s. *membrana antibrachii interossea*) unites the two bones of the fore-arm in most of their length. It occupies the deepest region of the fore-arm, being situated between the extensor and the flexor muscles. Its upper part commences below the tubercle of the radius. It is attached in its whole extent to the external edge of the ulna, and to the internal edge of the radius, and extends almost to the lower extremity of the bones of the fore-arm; so that its lower part is much broader than its upper.

It is formed of parallel fibres; these descend from the radius to the ulna, and are much stronger at its upper than at its lower part. In several places, particularly above and below, we observe foramina for the passage of the interosseous vessels.

III. INFERIOR REGION.

SYNOVIAL CAPSULE.

§ 896. The inferior extremities of the bones of the fore-arm are united by a very loose and very broad *synovial capsule* (*membrana capsularis sacciformis extremitatum inferiorum cubiti*), which is strengthened only by some straight and isolated fibres. This capsule arises on the ulna from the semilunar cavity and on the radius from the corresponding eminence.

ARTICLE FIFTH.

OF THE LIGAMENTS BETWEEN THE FORE-ARM AND THE WRIST.

§ 897. The articulation of the bones of the fore-arm with those of the wrist* presents a thin and loose synovial capsule and some very strong fibrous bands, which cover its external surface.

I. SYNOVIAL CAPSULE.

§ 898. The synovial capsule arises above from the edge of the triangular and cartilaginous articular surface at the lower extremity of the radius, and from a fibro-cartilage which terminates this articular surface forward; below, from the cartilaginous circumference of the superior or antibrachial articular facet of the scaphoid, the semilunar, and the pyramidal bones, consequently from the bones of the upper range of the carpus, except the pisiform bone, and also fills the spaces between these bones. Prolongations, called *mucous* ligaments (*ligamenta mucosa*), go from several of its parts, among which we distinguish that which proceeds from the union of the two first bones of the carpus to the projection which arises between the two portions of the articular surface of the radius. These prolongations increase the extent of the surface which secretes synovia.

II. INTERARTICULAR CARTILAGE.

§ 899. The *interarticular cartilage* (*cartilago treangularis intermedia extremitatum ossium antibrachii*) (§ 898) is a small triangular fibro-cartilage; its base looks inward, and its summit outward; it is loose at its external edge, and its internal edge is attached to the anterior edge of the lower articular surface of the radius; and it is situated between the lower edge of the ulna and the semilunar bone. Its upper face is covered by the synovial capsule, and the inferior by the synovial membrane of the articulation of the fore-arm with the carpus, so that it belongs to neither; but as it evidently concurs to form the articular surfaces of the bones of the fore-arm, which correspond to the carpus, we must study it here, instead of describing it when treating of the articulations of the bones of the fore-arm, as is generally done.

* The carpal ligaments in the back and the palm of the hand, and also the proper carpal ligament in the palm of the hand, are not mentioned here, as they serve not to unite the bones, but only to retain the tendons in their places. They will be described in myology.

III. FIBROUS LIGAMENTS.

§ 900. We may describe, as is most usual, four principal fibrous ligaments, which strengthen the synovial capsule of this joint; the *palmar*, the *dorsal*, the *radial*, and the *ulnar*. The first two are larger and particularly broader than the others.

I. FIBROUS PALMAR LIGAMENT.

§ 901. The *fibrous palmar*, or the *anterior* ligament (*Lig. accessorium articuli cubito-carpalis*, s. *lacerti adscititii palmaris*, with the *Lig. accessorium, obliquum et rectum*) is composed of mostly horizontal bands, which leave the lower extremity of the palmar face of the radius and the styloid process of the ulna, go a little outward, meet, and unite, being attached to the palmar face of the pyramidal and the semilunar bones. These bands form particularly the *oblique accessory* ligament (*Lig. accessorium obliquum*, Weitbrecht.)

Besides, from the posterior part of the palmar face of the inferior edge of the radius arise strong perpendicular fibres, which are attached above the preceding to the upper edge of the palmar face of the pyramidal and semilunar bones, thus forming the *straight accessory* ligament (*Lig. accessorium rectum.*)

These fibres are generally interrupted in parts.

II. FIBROUS DORSAL LIGAMENT.

§ 902. The *fibrous dorsal* ligament (*Lig. fibrosum dorsale articuli cubito-palmaris*), or the *rhomboid* ligament (*Lig. rhomboideum*), is formed of several very strong bands which are also interrupted from place to place; these arise from the external edge of the articular face of the radius, go obliquely from before backward, and are attached to the dorsal face of the pyramidal bone. Their posterior part is the thickest, and there the fibres are most compactly arranged.

III. FIBROUS ANTERIOR OR RADIAL LIGAMENT.

§ 903. The *fibrous anterior* or *radial* ligament (*Lig. radiale articuli cubito-carpalis*) arises from the summit of the styloid process of the radius, unites at its upper part with the anterior bands of the dorsal ligament, and terminating rather pointedly, is attached to the anterior asperity of the radial face of the scaphoid bone.

IV. FIBROUS POSTERIOR OR ULNAR LIGAMENT.

§ 904. The *fibrous posterior* or *ulnar* ligament (*Lig. cubitale articuli cubito-carpalis*) is longer and stronger than the preceding, and

arises from the summit of the styloid process of the ulna, and, united with the posterior part of the dorsal ligament, is attached to the dorsal face and to the ulnar side of the pyramidal bone.

ARTICLE SIXTH.

OF THE LIGAMENTS OF THE CARPAL BONES.

§ 905. The ligaments of the carpal bones comprise those which unite the two ranges and those which unite the separate bones of the same.

I. OF THE LIGAMENTS BETWEEN THE TWO RANGES.

§ 906. The two ranges of carpal bones are connected together by a synovial capsule and by fibrous ligaments.

I. SYNOVIAL CAPSULE.

§ 907. The short and close *synovial capsule* extends from the first three bones of the upper range to the four bones the lower, unites with their cartilaginous faces and also sends small culs-de-sac between the adjacent bones, which are covered by the fibrous ligaments, by which the surfaces are kept in continual contact.

II. FIBROUS LIGAMENTS.

§ 908. The *fibrous* ligaments which exist only externally are very similar to those of the radio-carpal articulation, as respects situation, number, and proportional size.

The *palmar* ligament is short, but broad and triangular. Its central fibres are transverse, its anterior and posterior fibres are oblique ; all converge towards the base. They arise from the pyramidal and scaphoid bones, and are attached below to the trapezoides and the os magnum.

The *dorsal* ligament is weaker than the preceding. It is formed of transverse fibres, and partly of those which are a little oblique. It is attached above to the dorsal face of the three anterior bones of the upper range, and below, to the upper region of the dorsal face of the four bones of the lower range.

The *anterior lateral* ligament is formed of perpendicular fibres which extend from the radial side of the scophoid bone to the os trapezium.

The *posterior lateral* ligament is situated between the base of the unciform process of the unciform bone and the outer edge of the pyramidal bone.

III. LIGAMENTS BETWEEN THE PISIFORM BONE AND THE ANTERIOR RANGE.

§ 909. Besides these ligaments we find two others which are oblique; the upper is smaller, the lower is stronger; these go from the anterior extremity of the pisiform bone to the unciform bone: the second is attached to the inferior face of the body of this last bone, and the other to the summit of its unciform process.

II. OF THE ARTICULATION OF THE DIFFERENT CARPAL BONES.

I. SUPERIOR OR ANTIBRACHIAL RANGE.

A. ARTICULATION OF THE CORRESPONDING FACES.

§ 910. The four bones of the upper range of the carpus are articulated with each other differently, and do not possess the same degree of motion.

The corresponding faces of the three anterior bones are united superiorly by short, firm, and solid fibres, which cover the culs-de-sac of the synovial membrane (§ 907); these are called *transverse* or *interosseous* ligaments (*Lig. transversa*, s. *interossea*). The fourth on the contrary is attached to the pyramidal bone by a very loose capsule, the dorsal face of which is covered by transverse fibres.

B. ACCESSORY LIGAMENTS.

§ 911. Beside the interosseous ligament (§ 910) we also see, in several parts of the corresponding faces of the carpal bones, fibres, which go from one of these bones to another; these are called the *dorsal* and the *palmar* ligaments of this range. These ligaments are formed of transverse fibres. They unite with each other and also with the supplementary fibres of the synovial capsule, and are stronger in the palm of the hand than on the back.

II. INFERIOR OR METACARPAL RANGE.

§ 912. The corresponding faces of the os magnum and of the unciform bone, of the os magnum and of the trapezoides, are united by transverse and very tense interosseous ligaments, which are seen at their anterior portion. The strongest are situated between the first two bones.

We also observe in this range transverse *dorsal* and *palmar* ligaments, which are formed for the most part of several distinct bands; these extend from the different small bones of the anterior range to the bones adjacent, and usually to those of the succeeding range: we generally number three on each side; they are continuous with the fibrous ligaments of the articulation between the two ranges.

ARTICLE SEVENTH.

OF THE LIGAMENTS OF THE CARPO-METACARPAL ARTICULATION.

§ 913. The five metacarpal bones are united by synovial membranes and external fibrous ligaments with the bones of the anterior or inferior carpal range, and also by bands of fibres with the pisiform bone.

I. SYNOVIAL CAPSULE.

§ 914. The *synovial capsule* of the first metacarpal bone is loose and broad; it arises from the edge of the articular surface of the trapezium. The others are for the most part only prolongations of the common synovial capsule (§ 907).

II. FIBROUS LIGAMENTS.

§ 915. The synovial capsule of the first metacarpal bone is strengthened on the radial side by the tendons of the abductor muscles, and also on its edge by longitudinal fibres, which extend from the os trapezium to the first metacarpal bone. These fibres it is true do not exist everywhere, but they are strongest on the dorsal face; and as they are almost entirely deficient in some places, we usually number four ligaments in this articulation, the *dorsal*, the *palmar*, and two *lateral* ligaments, the *external*, and the *internal*.

§ 916. The fibrous ligaments of the four other metacarpal bones are divided into *dorsal* and *palmar*.

The *dorsal* ligaments are composed of oblique and perpendicular thin fibres, which are generally united in bands; these go from the dorsal faces of the anterior range of the carpal bones to the upper extremity of the dorsal faces of the metacarpal bones.

The *palmar* ligaments on the contrary are composed of more horizontal, and in part of more oblique fibres, which are mostly interlaced with the inferior palmar ligaments of the metacarpal bones. They extend from the palmar face of the anterior carpal range to the palmar face of the posterior extremity of the metacarpal bones.

The strongest of all these ligaments goes from the anterior extremity of the posterior face of the trapezium to the base of the third metacarpal bone, and is attached to its anterior edge.

We find also some superficial bands which extend from the summit of the unciform process of the unciform bone, from within outward, to the base of the fifth metacarpal bone.

§ 917. A very strong round ligament arises from the inferior extremity of the pisiform bone, and goes directly to the base of the fifth

metacarpal bone, and which, passing under the band extended from the unciform bone to the fifth metacarpal bone, goes obliquely to the base of the third and the fourth, where it unites with the large ligament described above (§ 909).

ARTICLE EIGHTH.

OF THE ARTICULATION OF THE METACARPAL BONES WITH EACH OTHER.

I. SYNOVIAL CAPSULE.

§ 918. The metacarpal bones of the second, third, fourth, and fifth fingers touch each other at their posterior extremities by smooth and cartilaginous surfaces, over which passes a synovial membrane, which is sometimes only a simple prolongation of the synovial capsule, situated between the posterior and the anterior ranges of the carpal bones (§ 910), but which sometimes also forms several distinct sacs.

The metacarpal bone of the thumb is entirely insulated from the others.

FIBROUS LIGAMENTS.

§ 919. The *fibrous* ligaments are situated between the posterior and the anterior extremities of the metacarpal bones. The posterior are of three kinds, the *dorsal*, the *palmar*, and the *lateral*; the anterior are single.

I. POSTERIOR FIBROUS LIGAMENTS.

§ 920. The *dorsal* ligaments are four; one between every two metacarpal bones.* All are composed of transverse fibres. They increase very much in breadth and power from the thumb to the fifth finger; the first is however larger than the second. Sometimes they are divided into two bands, an anterior and a posterior; the latter is broader.

The *lateral* ligaments are the narrowest of all. They are usually formed of several distinct bands, and descend below the former from the upper edge of the ulnar side of the metacarpal bone, to the lower edge of the radial side of the next bone; at the same time they turn a little forward.

The *inferior* or *palmar* ligaments are the strongest. They are formed of transverse fibres, and extend in this direction between the inferior faces of the bases of the adjacent metacarpal bones.

The lateral and palmar ligaments are sometimes deficient between the first and second metacarpal bones.

* Generally, only three are admitted, the ligament between the thumb and finger being considered deficient; but nice dissections convince us that this opinion is erroneous.

II. ANTERIOR FIBROUS LIGAMENTS.

§ 921. There are three *anterior fibrous* ligaments formed of transverse fibres ; they are very tense, and extend between the inferior faces of the heads of the second, third, fourth, and fifth metacarpal bones, where they are continuous with the tendinous fibres. They are much larger and more moveable than the preceding.

ARTICLE NINTH.

OF THE METACARPO-PHALANGEAN AND PHALANGEAN LIGAMENTS.

§ 922. The anterior extremities of the metacarpal bones, and the posterior extremities of the bones in the first phalanx, and also the three phalanges, are united exactly in the same manner, by synovial capsules and accessory ligaments.

I. SYNOVIAL CAPSULES.

§ 923. The *synovial capsules* are loose and broad, especially on the dorsal face of their circumference. At their upper portion, that which looks towards the fore-arm, they extend much farther on the inferior extremity of the upper of the two bones, between which they are found, so that beside the cartilaginous portion they embrace a considerable part which presents no cartilage.

The synovial capsule of the metacarpo-phalangean articulation is much looser and broader than are those of the phalangean articulations.

II. FIBROUS LIGAMENTS.

§ 924. Each of these articulations is confined by three strong ligaments, two *lateral* and an *inferior* ligament.

I. LATERAL LIGAMENTS.

§ 925. The two *lateral* ligaments, the *external*, and the *internal*, are rhomboidal, and formed of oblique fibres. They extend from the two rough depressions, at the two extremities of the head of the upper bone to the same depression in the base of the lower. Being attached directly to the lateral faces of the synovial capsule, they prevent it from separating on the sides.

II. INFERIOR LIGAMENT.

§ 926. The *inferior*, *internal*, or *anterior* ligament is situated on the

palmar face of the synovial capsule, and is intimately connected with it. It is composed of transverse fibres. Its tissue is fibro-cartilaginous. It forms a very thick square layer, which is more broad than long, and bi-concave, the upper face of which looks towards the articulation, and the lower to the flexor tendon.

The upper part of the synovial capsule has no special fibrous ligament, but it is strengthened by the tendon of the extensor muscle of the fingers.

III. UNGUAL LIGAMENTS.

§ 927. The *ungual* ligaments (*Lig. unguium*, s. *lateralia subtensa*) are fibrous, oblong, and rounded bands, situated on both sides of the bones in the third phalanx, and extend from the lateral tubercles of the base to those of the summit. These ligaments are united to the lateral edges of the roots of the nails, and serve to render them firm, and to enlarge the surface on which the nervous tissue of the fingers is expanded.

CHAPTER II.

OF THE LIGAMENTS OF THE INFERIOR EXTREMITIES.

§ 928. The ligaments of the lower extremities are—

1st. Those of the pelvis, and those which unite either the lower extremities to the trunk, or the upper parts of the lower extremities with each other.

2nd. The ligaments of the ilio-femoral joint.

3rd. The ligaments of the knee-joint.

4th. The ligaments of the leg.

5th. The ligaments of the tibio-tarsal joint.

6th. The ligaments of the tarsus.

7th. The ligaments of the tarso-metatarsal joint.

8th. The ligaments of the metatarso-phalangean and phalangean joints.

ARTICLE FIRST.

OF THE LIGAMENTS OF THE PELVIS.

§ 929. The bones of the pelvis are connected by fibro-cartilages and by fibrous ligaments; but there are no apparent synovial capsules. The fibro-cartilages are the principal and most extensive modes of union. The fibrous ligaments only strengthen the joint formed by the fibro-cartilages; some pass upon these articulations, others go to other parts, so that they assist to form the walls of the pelvis, to increase

the surfaces for the insertion of the muscles, and to protect the vessels and nerves.

I. FIBRO-CARTILAGINOUS LIGAMENTS.

§ 930. The articulations of the first kind are the *sacro-iliac symphysis* and the *symphysis pubis*.

I. SACRO ILIAC SYMPHYSIS.

§ 931. The *sacro-iliac symphysis* (*symphysis sacro-iliaca*) unites the sacrum with the iliac bones.

The mode of articulation is not the same in all parts.

The smaller anterior and ear-shaped part of each of these two bones is covered with a smooth cartilage. These two cartilages touch; but they are rarely united, at least completely. They are very distinct from each other and smooth in youth; but as age advances they become rougher. We even find between them a fluid, which is thicker and less liquid than synovia.

The two bones are very differently articulated at their larger posterior part. The bones there have no cartilage, are very rough and separated very far from each other, especially upward and backward, and are united by a very dense, strong, felt-like, fibro-cartilaginous, irregular mass, formed particularly of transverse fibres; this mass is never torn, even when the bones are forcibly separated in this point, but detaches itself from one bone and remains fixed to the other.

We may consider this posterior part of the sacro-iliac symphysis as a particular ligament. This has been done by Bichat, who terms it the *sacro-iliac* ligament (*Lig. sacro-iliacum*).*

II. SYMPHYSIS PUBIS.

§ 932. The symphysis pubis is situated between the upper parts of the descending branches of the pubis.

The upper convex portion of the descending branch of the pubis is covered by a thin cartilage, which diminishes from above downward. This cartilage is entirely covered upward, downward, forward, and backward, by a very thick layer of ligament, formed of transverse fibres, which are strongly developed at the lower part of the symphysis, and which are continuous with the periosteum and with the tendons of the adjacent muscles. This mass is generally thin on its internal face, but often also projects longitudinally, a difference not dependent on the sex, although sex has no influence upon it.

* W. Hunter, *Remarks on the symphysis of the ossa pubis*; in the *London Med. Obs. and Enq.*, vol. ii p. 321—339—Tenon, *Mém. sur les os du bassin de la femme*, in the *Mém. de l'Institut*, vol. vi. Paris, 1836, p. 149—201. This memoir points out very clearly the varieties in the arrangement of the symphysis.

This fibrous layer always renders the articulation much firmer, and is even the principal agent of it. Its firmness, however, is less than that of the fibro-cartilaginous layer in the sacro-iliac symphyses, since it is generally ruptured when the bones of the pubis are forcibly separated.

The internal arrangement of the joint is not everywhere the same. Many anatomists admit that the two articular cartilages of the pubis are always united, others assert that they are always separated; some think that, in the first case, they form a single cartilage. We have reason to think, however, that the last arrangement never exists, and that when a single cartilage only appears, there are, in fact, two, separated by a layer of fibro-cartilage, which intimately unites with them in their whole length, and is connected forward and backward with the fibrous layer already described; at least we have never found a single cartilage, and this arrangement is always seen when the cartilages are united. The mass of fibro-cartilage is inversely as that of cartilage.

The arrangement we have described is not general. At all periods of life, without distinction of age, sex, or any other circumstance, we find the two articular cartilages perfectly separated from each other by a greater or less space, and to a greater or less extent of their height, and united only at their lower extremity by a cartilage, or more properly by a fibro-cartilage, which may be removed without any suspicion of violence. If, sometimes, they are completely united, they are also often entirely separated at their posterior part. The first mode of articulation is most common in the male, and the second in the female; hence the sexes differ, if not constantly, at least primitively and really; for it is not the consequence of pregnancy and parturition, since it is found also in females before they have attained the age of puberty.

II. FIBROUS LIGAMENTS.

§ 933. Some of the *fibrous ligaments of the pelvis* are extended over the fibro-cartilages already described, and others attach the bones of the pelvis to its different parts. The former are *supplementary*, the latter *proper* ligaments.

I. SUPPLEMENTARY FIBROUS LIGAMENTS.

§ 934. The supplementary fibrous ligaments of the sacro-iliac symphysis are two, a *posterior* and an *anterior*.

A. LONG POSTERIOR LIGAMENT OF THE PELVIS.

§ 935. The *long posterior* ligament of the pelvis (*Lig. pelvis posticum*, s. *ossis ilei longum*, s. *superficialis*) extends almost perpendicularly, although a little from without inward, from the posterior extremity of

the iliac crest to the summit of the transverse process of the fourth false sacral vertebra. It is very strong, and its form is oblong.

B. SHORT POSTERIOR LIGAMENT OF THE PELVIS.

§ 936. The *short posterior* ligament of the pelvis (*Lig. pelvis*, s. *ilei posticum breve*, s. *profundum*) arises directly below the preceding; it follows the same direction with it, but is shorter and narrower. It is attached to the summit of the transverse process of the third false sacral vertebra.

§ 937. Besides these two ligaments, we also see arise from the posterior part of the internal face of the iliac crest some irregular fibres, which are for the most part oblique and flat, which intercross and proceed from below upward, from without inward, and from behind forward. They unite in several bands, placed one after another from above downward, on the posterior face of the lateral parts of the upper false vertebræ of the sacrum. They concur with the preceding ligaments to strengthen the sacro-iliac symphyses posteriorly.*

The latter fibres lead to the anterior pelvic ligaments, which strengthen the sacro-iliac symphysis anteriorly.

C. UPPER ANTERIOR PELVIC LIGAMENT.

§ 938. The *upper anterior pelvic* ligament (*Lig. pelvis anticum superius*) is composed of oblique fibres, which ascend from the commencement of the posterior third of the iliac crest to the transverse processes of the last two lumbar vertebræ. Its form is triangular; it is very thin, and usually perforated for the passage of vessels and nerves, especially when it ascends to the transverse process of the fourth lumbar vertebra.

D. LOWER ANTERIOR PELVIC LIGAMENT.

§ 939. The *lower anterior pelvic* ligament (*Lig. pelvis anticum inferius*) arises from the same point as the preceding, but a little lower and a little farther back. It ascends obliquely from before backward, and is inserted in the transverse process of the fifth lumbar vertebra. It sends fibres downward and forward, which are inserted in the cartilage between the last lumbar and the first sacral vertebra.

II. PROPER FIBROUS LIGAMENTS.

§ 940. The *proper fibrous* ligaments are three on each side, and serve less to keep the bones in their position than to complete the parietes of the pelvis, by a substance which is solid, but is yielding to a certain extent. Two of them are situated behind, one on each side of

* The *lateral posterior* ligament of the pelvis (*Lig. laterale posticum ossis ilei*) will not be described in this place, but in myology.

the pelvis; the third is found forward. The posterior two unite two bones, which are separated in the normal state; the anterior is extended between the different parts of one and the same bone.

A. SACRO-SCIATIC LIGAMENT.

§ 941. The *sacro-sciatic* ligament, the *large posterior pelvic* ligament, or the *external posterior pelvic* ligament (*Lig. pelvis posticum magnum*, s. *tuberoso-sacrum*) arises from the posterior and inferior iliac spine, from the posterior part of the external face of the inferior portion of the iliac bones, from the lateral edges, and from the outer part of the posterior face of the inferior portions of the sacrum and coccyx, goes obliquely forward, downward, and outward, contracts and thickens, and is attached to the internal edge of the inferior face of the sciatic tuberosity, where it again enlarges, and gives off a loose, falciform, and thin slip, which goes from the internal face of the ascending branch of the ischium to the descending branch of the same bone.

Beside (§ 940) the uses pointed out, it enlarges the surfaces of attachment of the glutæus maximus muscle, and closes the ischiatic notch, which changes into an oval foramen.

B. SMALL SACRO-SCIATIC LIGAMENT.

§ 942. The *small sacro-sciatic*, or the *sacro-spinal* ligament (*Lig. pelvis posticum parvum*, s. *spinoso-sacrum*) arises before the preceding, from the outer edge of the inferior portion of the sacrum and of the pieces of the coccyx. Its fibres go forward, outward, and upward; the upper fibres descend, the central are straight, and the inferior ascend. It crosses the preceding, and is attached to the sciatic spine. Its form is an equilateral triangle, and its internal face is usually muscular.

This ligament divides the great fissure or the sciatic foramen into two parts, an upper and a lower; the first is much larger, and is separated from the other by the parts which pass through it.

C. OBTURATOR MEMBRANE.

§ 943. The *obturator membrane* (*Lig.* s. *membrana obturatoria*, s. *foraminis thyroidei ossium pubis*) is thin, and formed of irregular fibres, which are mostly transverse and a little oblique, and which intercross variously. It arises from the sharp edges of the obturator foramen, further forward at its upper than at its lower portion, and it closes this opening almost entirely. We see at its upper and external part only a constant rounded and oblong hollow, through which the obturator vessels and nerves pass out from the cavity of the pelvis. But this hollow is partly though imperfectly filled, for one or more bands of very strong transverse fibres go from the anterior edge of the ascending branch of the ischium to the beginning of the external edge of the descending branch of the pubis, several lines behind the membrane;

so that it would seem as if the upper fibres had been separated from eachother in this place by the vessels and nerves which pass out from the pelvis.

This space deserves notice; since in thyroidal hernia, which is very rare, the abdominal viscera protrude from it and follow the course of the vessels.

We also find other openings in the obturator membrane, particularly at its lower part; but these are less constant.

III. CHANGES OF THE PELVIC LIGAMENTS DURING PREGNANCY.*

§ 944. Most usually, the bones of the pelvis have but a slight degree of motion on each other. Hence arises a question, whether this mobility is not increased under certain circumstances, and particularly if this change does not supervene during pregnancy.

Opinions differ in this respect. Some admit that the change occurs normally in every state of pregnancy. Others think it supervenes only under certain circumstances, as when the bones are diseased, or after very difficult labours; and others, that it never takes place.

The first of these opinions, already advanced by Pineau, is undoubtedly the most correct; since, according to the testimony of the best observers as Sandifort and Hunter, about the period of parturition, the symphyses, especially that of the pubis, always become looser, broader, and yield more easily. Beside, the latter symphysis is always broader in those females who are mothers of several children, than in virgins. This phenomenon deserves to be pointed out, as it demonstrates that all the parts interested in the act of parturition are analogously changed and become loose and more spungy.

Finally, this change does not necessarily imply a real separation of the pubic cartilages, but only the softening of the fibro-cartilage,—a state in which the articular cartilages do not seem to participate. Tenon has maintained the contrary, but he is wrong: if the cartilages have sometimes been found really separated, this state must be considered as congenital or morbid; since this arrangement has been observed even in very young girls, or the loose surfaces of the cartilages were likewise rough, or pus has been found in the cavity.†

This softening begins to take place in the eighth month of pregnancy, that is to say, precisely at that time when the lower region of the genital organs begins to enlarge and to secrete a great quantity of mucus.

* S. Pineau, *De distractione ossium pubis in partu naturali, deque rationibus quibus ea probatur; in libris de virginitatis notis, graviditate et partu*, book ii.—Sandifort, *De pelvi cjusque in partu dilatatione*, Leyden, 1763.—Hunter, *loc. cit.*—Louis, *Sur l'écartement des os du bassin*, in the *Mém. de l'ac. de chir.*, vol. iv. Paris, 1769. Hist. pp. 63—102.—Tenon, *loc. cit.*

† A singular case of the separation of the ossa pubis, in the *Med. obs. and inq.*, vol. ii. No. 28.

This phenomenon is important, as by it the pelvis is enlarged, and the act of parturition is facilitated. We must not confound it with the separation and the rupture of the cartilages, which may result from disease, either by destroying the fibro-cartilage between the two cartilages or by detaching the latter from the surfaces of bone, where the fibro-cartilage separates from the two lateral cartilages; so that then three cartilages are formed, two of which adhere, while the central one is loose.*

ARTICLE SECOND.

OF THE ILIO-FEMORAL ARTICULATION.

§ 945. The ilio-femoral joint is formed by the fibro-cartilaginous prolongation of the cotyloid cavity, a synovial capsule, a fibrous capsule, and an internal fibrous ligament.

I. FIBRO-CARTILAGINOUS LIGAMENT.

§ 946. The *fibro-cartilaginous* ligament of the cotyloid cavity, or the *cartilaginous lip* (*Lig. cotyloideum fibro-cartilagineum, acetabuli labrum cartilagineum*), is a complete triangular ring, formed of fibro-cartilage, which is several lines high and thick. It is thickest above and outward, and passes above the cotyloid fissure, so as to complete the edge of this cavity. Its loose edge is sharp and looks a little inward; hence this ligament serves also to enlarge the cotyloid cavity, but contracts its circumference, although but slightly.

This ligament is formed entirely of cartilaginous substance only where it passes over the cotyloid fissure.

The space below is filled by some bands, situated, one within, the other without—the *external* and *internal ligaments of the cartilaginous lip* (*Lig. labri cartilaginei externum et internum*), which are continuous, the first with the obturator membrane and both with the fibro-cartilage.

I. SYNOVIAL CAPSULE.

§ 947. The *synovial capsule* (*capsularis synovialis membrana*) passes from the bottom of the cotyloid cavity on the cartilaginous lip (§ 945). It is intimately connected with both, completely covers the external face of the lip, then is reflected on itself at an acute angle, and finally descends loosely to go to the femur. There it is attached to the lower extremity of the neck, goes to the anterior oblique line, descending lower forward than backward, reflects at an acute angle from below upward, and blends with the cartilage which covers the head.

* Tenon, *loc. cit., Onsieme obs.*, p. 174.

The posterior, superior, inferior, and external parts of the cotyloid cavity are covered by a semicircular cartilage, which extends, on all sides except the cotyloid notch, even to the loose edge of the cavity and to the cartilaginous lip, from which it is evidently separated. This cartilage is intimately connected with the synovial capsule.

The anterior and middle part of the cotyloid cavity is the deepest, and has an irregular quadrilateral form: it is rough, but is not covered with cartilage. It contains much articular fat. The synovial capsule adheres but slightly in this place, and is separated from the bone by layers of fat.

III. ROUND LIGAMENT.

§ 948. Directly before the portion of the synovial membrane which passes on the space below the bridge formed by the cartilaginous lip, arises a quadrangular ligament about an inch long, called the *round ligament of the femur* (*Lig. ossis femoris teres*, s. *rotundum*). The extremities of this ligament enlarge a little, and its outer end is attached to the bottom of the cavity in the head of the femur. It retains this bone more firmly in its situation.

It is formed of longitudinal fibres, which are attached to the upper and lower horns of the cotyloid fissure, and unite with the ligaments of the cartilaginous lip, and also with the lip itself; but they are covered in all their circumference by a sheath of synovial membrane, which is reflected on itself.

This ligament prevents the luxation of the femur upward, outward, and downward, as it prevents the femur from escaping in that direction: it is at least necessarily broken when this dislocation takes place, although the femur can quit the cotyloid cavity forward without its being ruptured.

§ 949. The round ligament is sometimes deficient, either primitively or from a violent and often repeated compression of the ilio-femoral joint.

IV. FIBROUS CAPSULE.

§ 950. The *fibrous capsule* (*capsula fibrosa ossis femoris*) is the strongest and most perfect of all in the body. It arises above from the circumference of the inferior edge of the outer face of the cartilaginous lip, unites very narrowly in its whole extent with the external face of the synovial capsule, and is attached to the lower extremity of the head of the femur exactly in that part where the outer part of the capsule is reflected to cover the neck of the bone. It is very strong at its upper external and anterior portion, is two or three lines thick, and is formed of several superimposed layers of longitudinal fibres.

This capsule is protected by the adjacent muscles of the thigh; although the tendons of the muscles are not connected with it.

From its upper, anterior and internal part arise several bands, which ascend obliquely toward the internal part of the anterior face of the horizontal branch of the pubis and the anterior face of the obturator membrane, with the fibres of which they are blended.

ARTICLE THIRD.

OF THE ARTICULATION OF THE KNEE.

§ 951. The knee-joint is the most complex articulation in the body; for the synovial capsule is not only strengthened externally by three fibrous ligaments, but the corresponding surfaces of the femur and tibia are attached within this capsule by strong fibrous ligaments, which are even their principal mode of union. From this arrangement, the knee-joint is also the strongest of all. What renders the joint more complex is, that the two bones are separated from each other by an interarticular cartilage.

I. SYNOVIAL MEMBRANE.

§ 952. The *synovial membrane* (*membrana synovialis articuli genu*) rises some lines before the cartilage of the articular surface of the femur, and backward from directly above this same cartilage. It is attached below to all the circumference of the rough edge of the upper articular cartilaginous surface of the tibia.

Its upper and lower faces unite with the cartilages which cover the articular surfaces of the two bones. A part of its anterior face covers also the posterior face and the lateral edges of the patella; so that the patella slightly projects within the cavity.

Beside, its upper and anterior portion covers rather closely the lower part of the extensor muscle of the leg, from which however it may be separated more easily than from the bone. The rest is united to the adjacent parts only by a very loose mucous tissue.

The lower part of the cavity which it thus forms is divided into a right and a left portion; because a perpendicular fold is formed, which loose upward and extends from the posterior intercondyloid fossa of the femur to the anterior part of its circumference behind the ligament of the patella, and which is attached in this place below the patella itself.

We find considerable accumulations of articular fat in many parts, especially on the anterior wall, around the patella, in the fold we have mentioned, and behind the condyles of the femur.

The whole capsule is very broad and loose, especially at its anterior part; less so, however, on the sides, which must be ascribed to the nature of the motions of the leg, which are only flexion and extension.

The outer face of the synovial membrane is strengthened behind by oblique fibres, which descend from the external condyle of the femur to the internal condyle of the tibia.

II. EXTERNAL FIBROUS LIGAMENTS.

§ 953. On the circumference of the synovial membrane we find an internal and two external lateral fibrous ligaments.

I. INTERNAL LATERAL LIGAMENT.

§ 954. The *internal lateral* ligament (*Lig. laterale internum*) is the strongest, and is formed of perpendicular fibres. It descends from the anterior part of the internal face of the inner condyle to the upper part of the internal face of the tibia, where it is attached. It is broader above than below and is triangular, the base of the triangle being turned forward. It prevents the articular surfaces from being dislocated inward.

II. LONG EXTERNAL LATERAL LIGAMENT.

§ 955. The *long, anterior, or external lateral* ligament (*Lig. genu laterale externum*, s. *longum*, s. *anterius*) forms an oblong, rounded, firm band. It is situated before the short ligament, between the lower extremity of the external condyle, from the external face of which it arises below, and the anterior part of the external face of the head of the fibula, to which it is attached.

III. SHORT EXTERNAL LATERAL LIGAMENT.

§ 956. The *short external* or *posterior lateral* ligament (*Lig. genu laterale externum breve* s. *posterius*) is still feebler than the preceding. It arises a little above, and half an inch behind it, from the inferior part of the posterior face of the external condyle of the femur, goes a little obliquely from above downward and from within outward, and is attached to the summit of the head of the tibia, higher than the preceding.

The two external lateral ligaments prevent the luxation of the knee-joint outward. The terms *anterior* and *posterior* are more convenient than those generally used, as the length of both is the same or nearly the same.

III. INTERNAL FIBROUS OR CRUCIAL LIGAMENTS.

§ 957. The *crucial* ligaments (*Lig. cruciata genu*) are the strongest of all the connections between the femur and the tibia. We find two an *anterior* and a *posterior*.

The *posterior* is longer, broader, and stronger than the other, and its lower part is thicker but narrower than the upper part. It extends

from the posterior extremity of the depression between the two condyles of the tibia, toward the anterior extremity of the posterior intercondyloid fossa, at the internal face of the external condyle of the femur, where it is attached by a semicircular edge. Its direction is from below upward, from behind forward, and from within outward.

The *anterior* arises from the anterior extremity of the internal point on the upper articular face of the tibia, goes outward, upward, and backward, crosses the preceding but does not touch it, and is attached a little behind it to the internal face of the outer condyle of the femur.

These ligaments unite the tibia to the femur firmly, and also limit the turning of these bones on their axes. The posterior opposes the rotation of the thigh outward and that of the leg inward, while the anterior prevents the rotation of the thigh inward and that of the leg outward.

IV. SEMILUNAR CARTILAGES.

§ 958. The *semilunar* or *falciform* cartilages (*cartilagines interarticulares genu semilunares*, s. *falcatæ*) derive their name from their form. Both are broader behind than before: the external edge, which is convex, is much thicker than the internal, which is concave and terminates obliquely in a point. The first adheres intimately to the synovial capsule, while the second is entirely loose; but their two extremities are attached by a strong fibrous ligament to the posterior part of the intercondyloid fossa of the tibia. Another strong transverse ligament unites them at their anterior extremities. Their inferior faces are plain, but their superior are concave to a greater or less extent, and pointed near the two extremities. Each rests on one of the portions of the cartilaginous face of the tibia, and corresponds to one of the condyles of the femur. They are separated by the eminence on the upper articular face of the tibia, and their concave edges are turned toward each other.

The *external falciform* cartilage is uniformly broader than the internal in its whole extent, and also a little larger; hence it covers more of the upper face of the external condyle of the tibia. Its posterior extremity is very firmly attached to the fossa placed behind the spine of the tibia. It is also attached to the femur by a very strong ligament, which arises more posteriorly, ascends obliquely from without inward between the two crucial ligaments, and is inserted directly behind the posterior, on the internal face of the internal condyle of the femur. Its anterior extremity, which is reflected from before backward behind the anterior articular ligament of the two cartilages, is attached to the anterior part of the depression before the spine of the tibia, directly behind the lower extremity of the anterior crucial ligament.

The *internal falciform* cartilage is attached by its posterior extremity farther inward and backward than the external, directly before the posterior crucial ligament, at the posterior extremity of the depression placed behind the spine of the tibia, much farther forward and outward than the external.

These two cartilages elevate the edge of the upper articular surface of the tibia, and thus impede the gliding of the condyles of the femur; but they prevent particularly the compression of the femur and the tibia in the motions of the leg.

§ 959. Of all the joints, the articulation of the knee is the most subject to morbid alterations of texture, although it is not often dislocated, since the arrangement and firmness of its fibrous ligaments admit of but slight motions.

In this particularly, above all, other articulations, abnormal bones and cartilages are developed, which are at first attached to the synovial membrane by thin peduncles, but which in time are detached and isolated.

This articulation is almost the only one exposed to *fungus of the joints* (*fungus articulorum*).

These conditions depend, partly on its great size, or partly on its position, as it is exposed to mechanical injury and compression more than any other joint.

ARTICLE FOURTH.

OF THE ARTICULATIONS OF THE BONES OF THE LEG.

§ 960. The bones of the leg are attached to each other at their upper, middle, and lower portions.

I. UPPER ARTICULATION.

§ 961. The upper articulation of the two bones of the leg is formed by a short synovial membrane, the capsule of the head of the fibula (*Lig. capituli fibulæ*), which arises some lines above the head of the cartilaginous lateral articular facet of the tibia, and below the upper articular facet of the fibula, and the anterior face of which especially is strengthened by very strong transverse fibres, which extend from the internal edge of the head of the fibula to the external face of the upper extremity of the tibia.

II. MIDDLE ARTICULATION.

§ 962. The middle articulation is formed by the *interosseous* ligament (*Lig. interosseum*, s. *membrana interossea*). This ligament is thin and smooth; it gradually contracts from above downward, and is formed of oblique fibres, which descend from the external edge of the tibia to the crest of the fibula.

At its upper part we see a foramen, through which the anterior tibial vessels and nerves pass, and another below for the peroneal artery. We also occasionally see in all its extent similar but smaller openings.

It is situated between the flexor and the extensor muscles of the leg ; the fibres of which arise in part from its two faces.

III. INFERIOR ARTICULATION.

§ 963. Between the inferior extremities of the tibia and fibula a very narrow slip of the synovial membrane of the articulation of the foot extends in the form of a cul-de-sac, but there is no special articular capsule. This slip is attached by three broad fibrous bands.

I. ANTERIOR TIBIO-PERONEAL LIGAMENT.

§ 964. The *anterior tibio-peroneal* ligament (*Lig. tibio-fibulare anterius*) arises from the external part of the anterior face of the lower extremity of the tibia, and is attached to the inner part of the anterior face of the external malleolus. It is formed of fibres which descend obliquely from within outward.

II. POSTERIOR TIBIO-PERONEAL LIGAMENT.

§ 965. The *posterior tibio-peroneal* ligament (*Lig. tibio-fibulare posterius*) is formed of fibres, which follow the same direction as those of the preceding ; they extend from the external part of the posterior face of the inferior extremity of the tibia to the internal part of the posterior face of the external malleolus.

III. SUPERIOR TIBIO-PERONEAL LIGAMENT.

§ 966. The *superior tibio-peroneal* ligament (*Lig. tibia-fibulare superius*) is formed of fibres similar to, but much shorter than the two preceding, and extends from the external face of the tibia to the internal face of the fibula, directly above the inferior processes of these two bones.

§ 967. A division of the anterior (§ 963) and of the posterior (§ 664) ligament into two portions, an upper and a lower, is useless, and does not naturally exist.

ARTICLE FIFTH.

OF THE ARTICULATION OF THE FOOT.

I. SYNOVIAL CAPSULE.

§ 968. The *synovial capsule* of the joint of the foot (*membrana articuli pedis synovialis*) arises from the edge of the articular and cartilaginous face of the articulation of the tibia and fibula, and from the corresponding face of the astragalus. It blends with all these surfaces, and sends a slip between the tibia and the fibula (§ 963). It is every where very loose, but loosest at its external part.

II. FIBROUS LIGAMENTS.

§ 966. The synovial capsule is covered forward, backward, and on the sides, by several bands, which do not unite in a fibrous capsule, and which extend from the tibia and fibula to the astragalus and calcaneum.

I. ANTERIOR LIGAMENTS.

§ 970. We may admit two anterior ligaments, an *internal* and an *external*. The central part of the anterior wall of the synovial capsule being loose, its two ligaments are much thinner than the others.

The *internal anterior* ligament (*Lig. anterius internum*) is composed of perpendicular fibres, some of which ascend a little obliquely outward. It is larger than the external, and goes from one part of the anterior edge of the lower articular face of the tibia to the back of the scaphoid bone.

The *external anterior* ligament (*Lig. anterius externum*) arises from the anterior part of the outer face of the external malleolus, and being formed of oblique fibres, proceeds from without inward and from behind forward, and is attached to the outer part of the anterior face of the body of the astragalus. It is usually formed of two bands, situated one at the side of the other, and separated by an interval. The upper band is much larger than the lower. The whole ligament has an irregular quadrilateral form.

II. POSTERIOR LIGAMENTS.

§ 971. Usually there are two posterior ligaments, one superficial and the other deep. The *superficial posterior* ligament (*Lig. posterius superficiale*) has an elongated cylindrical form, and extends from the internal edge of the external malleolus, below the insertion of the posterior tibio-peroneal ligament, to the centre of the posterior edge of the body of the astragalus, where it is attached to an eminence of this bone. Usually, a special and smaller band is detached from this point, which unites to the preceding, but goes in a contrary direction downward and outward, to be inserted in the upper part of the internal face of the tuberosity of the calcaneum.

The *deep posterior* ligament (*Lig. posterius profundum*) is much stronger than the preceding, and is separated from it by fat and cellular tissue. It rests directly on the posterior wall of the synovial capsule, and is formed of longitudinal and oblique fibres, which arise from the posterior edge of the lower articular face of the tibia, and from the under part of the inner face of the external malleolus. These fibres converge and go downward, and are inserted above the preceding ligament in the posterior face of the body of the astragalus.

Sometimes the two ligaments are blended together.
The fibres which come from the fibula are always the strongest.

III. LATERAL LIGAMENTS.

§ 972. The *lateral ligaments* are much stronger than all the other fibrous ligaments.

A. EXTERNAL LATERAL LIGAMENT.

§ 973. The *external lateral* ligament (*Lig. laterale externum fibulæ rectum*, s. *perpendiculare*, s. *medium*, s. *triquetrum*) is much longer from above downward than from before backward, and gradually enlarges in the first direction. It extends from the summit of the internal malleolus to the external face of the calcaneum, to which it is attached, after dividing into an anterior and a posterior fasciculus.

B. INTERNAL LATERAL LIGAMENT.

§ 974. The *internal lateral* ligament, called generally the *triangular* ligament, and which might be called the *trapezoid* (*Lig. laterale internum deltoides, trapezium*), goes from the inferior edge of the internal malleolus to the internal faces of the astragalus and calcaneum. It is more broad than high, is lower than the external, but is broader and as strong. It blends with the inner anterior ligament forward, and with the internal portion of the deep posterior ligament backward.

ARTICLE SIXTH.

OF THE LIGAMENTS OF THE TARSUS.

§ 975. All the bones of the tarsus are confined by short and thick synovial capsules, over which in many parts fibrous ligaments are extended. The latter are divided into those of the back, of the sole, of the tibial and fibular edges of the foot.

I. LIGAMENTS OF THE POSTERIOR RANGE.

I. SYNOVIAL CAPSULE.

§ 976. The two bones of the posterior range are united by two synovial membranes, a *proper* and a *common*.

The *proper synovial capsule* (*capsula propria astragalo-calcanea*) arises below from the edges of the upper and cartilaginous face of the body of the calcaneum, extends a little backward, over the portion of this same face, which is not cartilaginous, and is attached above to the corresponding circumference of the cartilage on the cartilaginous inferior face of the body of the astragalus.

The *common synovial capsule* (*capsula communis*, s. *astragalo-calcaneo-scaphoidea*) will be described hereafter. It is situated between the upper cartilaginous face of the anterior process of the calcaneum and the lower face of the head of the astragalus.

II. FIBROUS LIGAMENTS.

§ 977. The two synovial capsules are strengthened in several parts by fibrous ligaments, and the proper capsules particularly by the lateral and the posterior ligaments of the articulation of the foot (§ 971).

Besides, a broad internal ligament extends from the internal part of the posterior face of the body of the astragalus, to the posterior part of the internal face of the calcaneum, and is called the *internal* and *posterior astragalo-calcanean* ligament (*Lig. astragalo-calcaneum internum*, s. *posterius*).

The anterior face is confined by an internal and an external ligament.

The *internal anterior astragalo-calcanean* ligament (*Lig. astragalo-calcaneum internum anterius*) extends from the internal extremity of the cartilaginous surface of the anterior process of the calcaneum to the internal face of the astragalus.

The *external astragalo-calcanean*, or *interosseous* ligament (*Lig. astragalo-calcaneum externum*, s. *interosseum*) is composed of five or six very strong fasciculi, which are situated behind one another, and which diminish in length very much from behind forward and also from without inward. These fasciculi go from the external rough part of the upper face of the anterior process of the calcaneum to the external face of the neck and head of the astragalus, and to the channeled and acartilaginous part of the inferior face which separates the upper faces of the body and the anterior process. They fill the large space between these two bones.

I. OF THE LIGAMENTS BETWEEN THE ANTERIOR AND THE POSTERIOR RANGE.

I. SYNOVIAL CAPSULES.

§ 978. There are two synovial capsules, one for the astragalus, the calcaneum, and the scaphoid bone; the other for the calcaneum and the cuboid bone.

The first, or the *astragalo-calcaneo-scaphoid* capsule, has already been mentioned (§ 976). It arises from the margin of the anterior articular face of the astragalus, forms a cul-de-sac backward, which is reflected on the upper articular face of the anterior process of the calcaneum, and goes to the circumference of the posterior articular face of the scaphoid bone, and is blended with its posterior cartilaginous face.

The proper, or the *calcaneo-cuboid* capsule (*capsula synovialis calcaneo-cuboidea*), extends between the corresponding articular faces of these two bones.

II. FIBROUS LIGAMENTS.

§ 979. The astragalus and the calcaneum are united to the scaphoid bone, and this latter to the cuboid bone by external fibrous ligaments.

A. CALCANEO-SCAPHOID LIGAMENTS.

§ 980. There are two *calcaneo-scaphoid* ligaments (*Lig. calcaneo-scaphoidea*), a *superior* and an *inferior*.

The *superior* is much weaker than the other, and arises from the anterior edge of the rough portion of the tuberosity of the calcaneum, and ascends obliquely from behind forward, and from without inward, where it is attached to the external extremity of the back of the scaphoid bone.

The *inferior*, much stronger than the superior, being formed of several distinct bands, is more broad than long. It extends from the anterior edge of the tuberosity of the calcaneum to the external part of the inferior face of the scaphoid bone. It forms, conjointly with the calcaneum and scaphoid bones, a cavity for the head of the astragalus.

B. ASTRAGALO-SCAPHOID LIGAMENT.

§ 981. The *astragalo-scaphoid* ligament (*Lig. astragalo-scaphoideum*) covers all the upper surface of the synovial capsule of the two bones. It is formed of thin fibres, the direction of which is from before backward. Some of these fibres proceed even to the cuneiform bones.

C. CALCANEO-CUBOID LIGAMENTS.

§ 982. The calcaneum is united to the cuboid bone by superior, external, and inferior ligaments.

The *superior* ligaments (*Lig. calcaneo-cuboidea superiora* s. *dorsalia*) are usually three in number, placed successively from without inward. They form thin and flat bands, which increase progressively in length, from within outward, and are situated between the upper edge of the articular face of the calcaneum and the same edge of the corresponding face of the cuboid bone.

The *external* ligament (*Lig. calcaneo-cuboideum externum* s. *fibulare*) extends as high as the cartilaginous faces of the two bones, on the outsides of which they are attached. It is also thin, but stronger than the superior.

The *inferior* ligament (*Lig. calcaneo-cuboideum inferius* s. *plantare*) may be considered as formed by three superimposed layers, each of

which is stronger than the other ligaments of these bones, and which unite to form one of the strongest fibrous ligaments of the tarsus, perhaps the strongest even in the whole body.

The *superficial* layer, the longest and strongest, arises directly from the lower face of the tuberosity of the calcaneum, and is attached to all the tuberosity of the cuboid bone.

The *central* layer is much shorter and narrower, and is not entirely covered on the inside by the preceding. We ought, properly speaking, to consider it as a continuation of the inferior calcaneo-scaphoid ligament (§ 980). It arises from the inner part of the anterior edge of the articular face of the calcaneum, and is attached behind to the internal part of the rough inferior face of the cuboid bone.

The deep layer is entirely covered by the superficial; but by the central layer, only at its internal part. It is formed of fibres which go more obliquely from without inward and forward. It arises from the same parts of the two bones, but a little more externally.

III. LIGAMENTS BETWEEN THE BONES OF THE ANTERIOR RANGE.

I. SCAPHOIDO-CUBOID LIGAMENTS.

§ 983. The scaphoid and cuboid bones are united, especially posteriorly, in their whole extent by the *interosseous* ligament (*Lig. interosseum scaphoideo-cuboideum*), the fibres of which are oblique, short, and very compact. We usually find a synovial capsule before this ligament.

§ 984. The external fibrous ligaments are two—

1st. The *dorsal scaphoido-cuboid* ligament (*Lig. scaphoideo-cuboideum dorsale*) which is square, and arises from fibres which extend obliquely from behind forward, and from within outward. It goes from the external edge of the scaphoid to the centre of the upper face of the cuboid bone.

2. The *plantar*, (*Lig. scaphoideo-cuboideum plantare*) has the same form and direction as the preceding, but is composed of fibres which are more detached from each other: it extends from the centre of the inferior face of the scaphoid bone to the centre of the internal edge of the cuboid bone.

II. LIGAMENTS BETWEEN THE SCAPHOID AND CUNEIFORM BONES.

§ 985. The ligaments which unite the scaphoid to the three cuneiform bones, are a synovial capsule and fibrous ligaments.

A. SYNOVIAL CAPSULE.

§ 986. The *synovial capsule* is situated between the commencement of the anterior face of the scaphoid bone, and the posterior face of the three cuneiform bones. It also penetrates between the latter.

B. FIBROUS LIGAMENTS.

§ 987. *a.* The *fibrous* ligaments are, the *dorsal*, the *internal*, and the *plantar*.

We may admit two dorsal ligaments (*Lig. scaphoideo-cuboidea dorsalia*), an internal and an external.

The *internal* is triangular, and extends from the anterior and external part of the upper face of the scaphoid bone to the upper face of the second cuneiform bone. Its fibres go forward and outward.

The *external* is smaller than the other, from which it is entirely separated, is square, and formed of fibres which proceed in the same direction. It arises more externally, immediately at the side of the preceding, and is attached to the upper face of the third cuneiform bone. It is blended with the dorsal scaphoido-cuboid ligament (§ 984).

b. A strong *internal* ligament, (*Lig. scaphoideo-cuboideum internum*), the fibres of which are straight and almost horizontal, extends from the anterior edge of the internal face of the scaphoid bone to the posterior part of the inner face of the first cuneiform bone, and unites these two bones in their whole extent.

c. We may admit three *plantar* ligaments. The *internal*, the strongest is the continuation of the preceding, but is thicker than it. It is square, and its fibres, which are straight, extend from the tuberosity of the scaphoid bone to that on the inferior face and the posterior edge of the first cuneiform bone.

The *central* is feebler, but longer, and arises at the side of the preceding a little more externally. It goes obliquely from before backward, and from without inward, to the posterior part of the inferior edge of the second cuneiform bone.

The *external*, which is feebler and situated more deeply, is composed of detached, oblique, and transverse fasciculi. It extends from the external and anterior part of the inferior face of the scaphoid bone, to the posterior extremity of the inferior edge of the second and third cuneiform bones.

III. LIGAMENTS BETWEEN THE CUBOID AND CUNEIFORM BONES.

§ 988. These ligaments are, a *synovial capsule* and *two fibrous ligaments*.

The *synovial capsule* is situated between the cartilaginous points of the cuboid and of the third cuneiform bones.

There are two fibrous ligaments, a dorsal and a plantar.

a. The *dorsal* ligament, which is not constant, being often entirely replaced by the dorsal scaphoido-cuboid ligament (§ 984), when it exists, is very feeble, and is situated at the external edge of this last: it is formed of longitudinal fibres, which extend from the back of the cuboid bone to the posterior extremity of the back of the third cuneiform bone.

b. The *plantar* ligament is much stronger, and is formed of several distinct fasciculi, the anterior of which is the largest, and which all extend transversely from the internal edge of the plantar face, and from the lower part of the inner face of the cuboid bone to the inferior face and to the inferior part of the internal face of the third cuneiform bone.

IV. LIGAMENTS OF THE CUNEIFORM BONES.

§ 989. 1st. The synovial capsules between the three cuneiform bones, arise from the common capsule between the scaphoid and the cuneiform bones (§ 986).

2d. The fibrous ligaments are—

a. The *dorsal* ligaments, which form several feeble layers of oblique and transverse fibres, which extend from the first to the second, and from this to the third cuneiform bone.

b. The *interosseous* ligaments, which are very firm transverse fibres, extend between the internal faces of the first and second, and of the second and third cuneiform bones, where there is no slip from the synovial capsule.

c. The *plantar* ligaments are firm but isolated and usually oblique bands, which go from the posterior part of the internal face of the first cuneiform bone to the posterior extremity of the inferior edge of the second, and from this to the posterior extremity of the inferior edge of the third. They unite with the interosseous and plantar scaphoido-cuboid ligament.

ARTICLE SEVENTH.

OF THE LIGAMENTS BETWEEN THE TARSUS AND METATARSUS.

I. SYNOVIAL CAPSULE.

§ 990. The synovial membrane between the bones of the metatarsus on one side, the three cuneiform and the cuboid bones on the other, are not arranged in the same manner in all parts nor in all subjects.

We however find a special synovial membrane between the anterior extremity of the first cuneiform bone and the posterior extremity of the first metatarsal bone.

Usually, the second metatarsal bone is united to the three cuneiform bones by a common synovial capsule.

We find a third synovial membrane between the third metatarsal and the third cuneiform bones.

Finally, the fourth and fifth metatarsal bones are united to the cuboid bone by a common capsule.

II. FIBROUS LIGAMENTS.

§ 991. The *fibrous* ligaments which strengthen these synovial membranes are divided into *dorsal* and *plantar*.

a. The *dorsal* form several square and thin bands, which go from the upper face of the bones of the metatarsus corresponding to the tarsal bones, to the posterior extremity of the latter. The fibres of the external are a little oblique from within outward and from behind forward; those of the internal go directly from before backward.

b. The *plantar* correspond to the dorsal: they are however, except the first, a little weaker. They are strengthened by the tendons of the tibialis anticus and posticus muscles.

We see also strong fibrous bands, which go from some of the metatarsal to the tarsal bones which do not articulate with them; for instance, from the base of the second and fourth metatarsal bones to the anterior extremity of the third cuneiform bone going directly from before backward, and from the plantar face of the posterior extremity of the fifth metatarsal bone, transversely, to the extremity of the third cuneiform bone.

The posterior part of the circumference of the articulation of the first cuneiform bone with the metatarsal bone of the first toe is also furnished with strong ligamentous fibres, which go directly from before backward.

ARTICLE EIGHTH.

OF THE LIGAMENTS OF THE METATARSAL BONES AND PHALANGES.

I. METATARSAL LIGAMENTS.

I. POSTERIOR LIGAMENTS.

§ 992. The metatarsal bones, except the first, have the corresponding faces of their posterior extremities covered by slips of the synovial membranes extended between them and the bones of the anterior range of the tarsus (§ 990).

The *fibrous* ligaments resemble those of the metacarpus (§ 919 to 921). They are divided into *dorsal*, *middle*, and *plantar*.

The *upper* or *dorsal* (*Lig. ossium metacarpi dorsalia*) are formed of transverse fibres, which arise from the dorsal side of the corresponding faces of the posterior extremity of the adjacent bones. We find only five of them, because the metatarsal bone of the first toe does not articulate in this manner with the second. The upper ligament is however replaced by an analogous ligament, which extends from the cuneiform bone to the base of the second metatarsal bone.

The *middle* or *interosseous* ligaments (*Lig. ossium metatarsi media* s. *interossea*) are sometimes only three in number, and proceed obliquely from above and inward to go to the next metatarsal bone; more frequently however there are four. Similar fibres exist also between the first and second metatarsal bones.

The *inferior* or *plantar* ligaments (*Lig. ossium metatarsi inferiora* s. *plantaria*) are like the dorsal, only three in number, and are the strongest. The ligament between the first and second metatarsal bone becomes a very strong fibrous layer, which extends from the first cuneiform bone to the second and third metatarsal bones.

The fibres of this very long ligament proceed in a direction opposite to that of those between the fourth and fifth metatarsal bones; that is, the former go from behind forward and from within outward, the latter from without inward and from behind forward, so that they converge anteriorly.

II. ANTERIOR LIGAMENTS.

§ 993. On the plantar face between the anterior extremities of all the metatarsal bones, are very strong square ligaments, formed of longitudinal fibres, which are attached to the synovial capsules rather than to the bones. These are called the *anterior metatarsal* ligaments (*Lig. metatarsi anteriora plantaria*).

II. LIGAMENTS OF THE TOES.

§ 994. Synovial capsules, with lateral and inferior fibrous ligaments, exist between the posterior phalanx of each toe and the corresponding metatarsal bone, and also between the different phalanges. The final phalanges also have ungual ligaments. These parts being similar to those of the hand (§ 922—927), it is unnecessary to describe them.

BOOK III.

OF MYOLOGY.

§ 995. The general characters of the muscles * have been mentioned in our General Anatomy. We shall here describe only the voluntary muscles, and not all even of these; but shall confine ourselves to those which move the bones; the history of all the others being placed more conveniently after the description of the parts which they move, with which we must first be acquainted, if we wish to have an exact idea of the attachments of the muscles and of their modes of action. The system of the involuntary muscles is distributed in the vascular system and the viscera, in describing which also they will be examined.

§ 996. We consider as single muscles all those parts of the muscular system which can be separated from each other without dividing the fibres. In this manner we count in the normal state two hundred and thirty-eight different muscles, six of which are unmated and composed of two parts which unite on the median line, and two hundred and thirty-two are in pairs; so that the whole number of the muscles is four hundred and seventy.

The nomenclature of these muscles is not uniform: for a long time the inconvenient method of numbering them was used. It is, however, equally inconvenient to establish a uniform principle of nomenclature in myology, by changing the names of the muscles into descriptions of their situations and attachments, as Dumas and Chaussier have done; for then the extremely long and very complex names resemble each other too much.

The muscles derive their names principally from their modes of action, their attachments, their form, and their volume.

* Among the descriptions we shall mention: Stenon, *Elementorum myologiæ specimen*, Amsterdam, 1669.—Douglas, *Myographiæ comparatæ specimen*, Leyden, 1729.—Garengeot, *Myologie humaine et canine*, Paris, 1728.—Albinus, *Historia musculorum hominis*, Leyden, 1734.—Duverney, *l'Art de disséquer méthodiquement les muscles du corps humain*, Paris, 1749.—G. F. Petersen, *Gründliche anweisung zu der Zergliederung der Muskeln des menschlichen Körpers*, Hamburg, 1736.—J. Innes, *A short account of the human muscles*, Edinburgh, 1788.—J. G. Walter, *Myologisches Handbuch*, Berlin, 1777.—Sandifort, *Descriptio musculorum hominis*, Leyden, 1781.—Gavard, *Traité de myologie suivant la méthode de Desault*, Paris, an vii.—Fleischmann, *Anleitung zur Kenntniss der Muskeln des menschlichen Körpers*, Erlangen, 1811.—The principal plates are: G. Cowper, *Myotomia reformata*, London, 1724.—*Myologie complète en couleur et de grandeur naturelle*, Paris, 1746.—Albinus, *Tabulæ sceleti et musculorum corporis humani*, Leyden, 1747.—Duverney, *Tabulæ anatomicæ*, 1748.—G. G. Müller, *XII. Kupfertafeln welche die meisten kleinen und zarten Muskeln des menschlichen Körpers vorstellen*, Erfort, 1755. J. Innes, *Eight anatomical tables of the human body, containing the principal parts of the skeleton, muscles, etc.*, Edinburgh, 1776.—J. Bell, *Engravings explaining the anatomy of the bones, muscles, and joints*, London, 1805.—Lewis, *Views of the muscles of the human body*, London, 1820.

For the same reason that we commenced in osteology by describing the vertebral column, we shall mention first the muscles of the trunk, then those of the head, and lastly those of the extremities.

These three large divisions of the body, from the great number of their muscles and the different layers that they form, are usually subdivided into a greater or less number of *regions* (*regiones*), which modern writers have too extensively multiplied, by insulating the descriptions of the different muscles and by disregarding undoubted analogies.

When about to describe the muscles, a great difficulty presents itself relative to the order which we should adopt. Must we follow the *anatomical* order, which regards only the situation and the manner in which the different layers succeed each other? or the *physiological* order, which is founded on their action, so that those muscles which should be considered together or immediatly after each other, according to the first method, are separated from each other and allied on the contrary to others, which the anatomical order would separate from them? Thus, for instance, many of the muscles which move the upper extremities are muscles of the back if we consider their situation; so that they are generally referred to this region. The custom of considering the muscles according to their situation and the order in which they succeed each other is also proper; since it presents all their relations more exactly and allows us to demonstrate the different layers in the presence of the pupil. This then is the order which we shall adopt, always however with the proviso mentioned above (§ 995).

SECTION I.

OF THE MUSCLES OF THE TRUNK.

§ 997. The muscles of the trunk are divided into those which move the different bones of the trunk and head, and into those which go from the trunk to the first two divisions of the upper limbs: the latter, although they do not act on the bones of the trunk, deserve to be considered in this place, because many of them form the external layers of the muscles situated on the trunk and cover the others. The best method of classing them is to make two series—

1. The *posterior muscles of the trunk*, or the muscles of the back and the posterior muscles of the neck.

2. The *anterior muscles of the trunk*, or the muscles of the abdomen, of the thorax, and of the anterior part of the neck.

CHAPTER I.

MUSCLES OF THE BACK.

§ 998. The muscles situated on the posterior part of the trunk, or on its dorsal side (*musculi dorsales*), form several superimposed layers, which are four in number, and which differ in their attachments and also in their modes of action. The external muscles are for the most part larger, but they are fewer. They cover the other muscles of the back and belong to the class of the *broad* muscles. Those below them are more oblong; most of them are *short*, especially those situated most deeply. Some are composed of several short separate bellies.

In regard to the functions and attachments of these muscles, we may say, that most of them belong to the vertebræ, the head, and the ribs; for but few are attached to the bones of the upper extremities.

The superficial belong to the second section and the deep-seated to the first.

The direction of the fibres is not the same in all. In some for instance, as the trapezius and the latissimus dorsi, it varies in the different regions. But in most of the others it is the same every where. We may remark generally, that no muscle of the back is composed entirely of longitudinal fibres, which are found only in the centre of the trapezius and in the upper part of the latissimus dorsi. The fibres of all the others are more or less longitudinal. The latter may be referred to three classes.

First, those which ascend in a straight line and which move the parts in that direction. These are the sacro-lumbalis and longissimus dorsi muscles, the cervicalis decendens, the interspinales and their corresponding muscles, the rectus capitis posticus major and minor, the intertransversarii, and the lateral muscles of the head, which correspond to them; these may be called the straight muscles of the back (*M. dorsales recti*).

Second, those which descend obliquely outward; some arise from the spinous processes, and are attached to the transverse processes of the lower vertebræ, to the ribs, or to the scapula; others proceed from the transverse processes and go to the scapula or to the ribs; finally, some proceed from one rib to the following. We may call them the descending oblique muscles (*M. dorsales obliqui descendentes*) from their analogy to abdominal muscles; these are, considering them from without inward, the levator scapulæ, the rhomboidei, the serratus anticus and posticus, the complexus, the digastricus, the spinales colli, the transspinales dorsi, the multifidus spinæ, the obliquus capitis superior, the supracostales, the scaleni, and the intercostales externi.

Third, those which descend obliquely outward, or the ascending oblique muscles (*M. obliqui dorsales ascendentes*). They extend either from the transverse to the spinous processes, or from the internal

part of these latter to the bones situated more externally. They are, considering them from the surface internally, the splenii, the serratus posticus inferior, the transversalis, the complexus colli, and the obliquus capitis inferior muscles.

ARTICLE FIRST.

MUSCLES OF THE FIRST, SUPERFICIAL, OR EXTERNAL LAYER.

§ 999. The external layer is composed of two muscles, the trapezius and the latissimus dorsi, which are attached not only to the bones of the trunk and which serve principally to move the upper extremities.

I. TRAPEZIUS.

§ 1000. The trapezius muscle, *Dorso-sus-acromien*, Ch. (*M. cucullaris*, s. *trapezius*) is so called from its position and its figure when united to that of the opposite side. In fact each of these muscles has an inequilateral triangular form, the base of which looks inward. They unite on the median line, from the centre of the squamous portion of the occipital bone to the last dorsal vertebra, so that they cover the region of the neck, the back, and the shoulder. This muscle at its lower part is still more superficial than the latissimus dorsi, the upper and inner part of which it covers.

This broad, flat, and thin muscle arises, first, from the external occipital protuberance, and from a greater or less portion of the upper curved line of the occipital bone, and rarely also from the mastoid process of the temporal bone; second, from the cervical ligament, where it blends with that of the opposite side; third, from the spinous processes of the last cervical, and of the eighth, ninth, tenth, eleventh, and twelfth dorsal vertebræ, also from the interspinal ligaments, where the muscles of the two sides meet. The fibres which come from this last point have in general a very short tendon, except at the centre and at the inferior extremity.

The muscle is attached to the posterior edge, and to the upper face of the external or posterior part of the clavicle, to the acromion process, and to almost all the loose edge of the spine of the scapula.

The upper fibres descend obliquely from behind forward and from within outward, the centre are longitudinal, and the inferior ascend from within outward; it is much thicker at its upper than at its lower part, and is broadest in the centre. Its fixed point is the vertebral column, so that it acts principally on the scapula and clavicle, which it draws upward by its upper part; inward, backward, and from the side of the opposite shoulder, by its central part; below and inward by the lower portion. When all its parts contract simultaneously, it draws

these bones, and with them the whole upper extremity, backward. Its upper portion also draws the head backward and bends the neck.

II. LATISSIMUS DORSI.

§ 1001. The *latissimus dorsi* muscle, *Lombo-humeral*, Ch. occupies the lower part of the back and the whole lumbar region. Its form is triangular, and it arises from the summit of the spinous processes of from four to eight of the lower dorsal, of all the lumbar, and of the sacral vertebræ, from the transverse processes of the sacrum, where it is continuous with the glutæas maximus muscle, and from the outward lip of the central portion of the crest of the ilium, by a tendon which gradually enlarges from below upward, and finally becomes very large; and lastly, from the external face of the four lower ribs, near their anterior extremity, by four fleshy digitations, between which the lower digitations of the obliquus abdominis externus muscle are situated. It is attached by a strong tendon to the posterior lip of the bicipital groove of the humerus, directly behind its small tubercle, so that it forms the external wall of the hollow of the axilla. The centre of its upper edge covers the inferior part of the scapula, and it is usually strengthened in this place by a strong fasciculus, which arises from the inferior angle.

The tendon of the latissimus dorsi turns from below upward and from behind forward on the inferior edge of the teres major muscle, with which it is for the most part united. But towards its extremity they most generally separate, and a large bursa mucosa exists between them. At its point of insertion it unites slightly with the tendon of the pectoralis major muscle. Towards its internal extremity, the inferior edge of its tendon sends a tendinous band to the brachial aponeurosis. A second is detached from its posterior face, and goes to the small tubercle of the humerus.

The latissimus dorsi is very thin in its inner part, especially at its upper portion, but gradually increases in thickness from within outward and is finally considerably thick. Its upper fibres are longitudinal and the lower ones are oblique; the latter become straighter as they arise more externally, and are finally almost perpendicular. This muscle acts principally on the upper extremities which it draws downward and backward; hence the obscene but very significant term *anitersor* or *anisealptor*. When however the upper extremity is fixed, it will draw the ribs to which it is attached upward and outward, so that it acts whenever respitation is very much impeded. Farther, it will, under the same circumstances, move the trunk upon the upper extremity, and raise or bend it.

§ 1002. A fleshy or tendinous band not unfrequently (about once in thirty times) detaches itself from the upper part of the latissimus dorsi, before the coraco-brachialis muscle, and goes to the posterior face of the tendon of the pectoralis major muscle, to which it is attached. This peculiar arrangement, which is found in the normal state in the mole

and in birds, renders the brachial vessels and nerves very liable to compression.* Sometimes also, but more rarely, a similar band goes to the coracoid process of the scapula, where it unites with the upper extremity of the coraco-brachialis muscle.†

ARTICLE SECOND.

MUSCLES OF THE SECOND LAYER.

§ 1003. The second layer is formed by the rhomboidei, the levator anguli scapulæ, the splenii, and the serrati muscles, which partially or wholly cover each other. All are thin, and vary in length and breadth.

RHOMBOIDEI MUSCLES.

§ 1004. The *rhomboidei muscles*, *Dorso-scapulaire*, Ch. are the most superficial; they occupy most of the space between the vertebral column and the scapula.

A. RHOMBOIDEUS MAJOR.

§ 1005. The *rhomboideus major*, or the inferior rhomboid muscle, arises by short tendons from the lateral part of the summits of the spinous processes of the four, and sometimes of the five, upper dorsal vertebræ, sometimes even of the last cervical vertebra, and is attached to most of the external lip of the base of the scapula, from its triangular surface to near its inferior angle. Its fibres are parallel, and go obliquely outward and downward.

B. RHOMBOIDEUS MINOR.

§ 1006. The *rhomboideus minor*, or *superior rhomboid* muscle, is situated directly above the preceding, and is sometimes blended with it. It is about one fourth the size of it. It arises from the first dorsal, and from the seventh and sometimes the sixth and fifth cervical vertebræ, and is attached, its fibres having the same direction, to that part of the base of the scapula which the preceding does not occupy. At its origin, it is at first blended with the serratus magnus muscle which passes over it.

The uses of these muscles are nearly the same; they draw the scapula upward and backward, and consequently act in shrugging the shoulders.

* Wardrop, in the *Edin. Med. Journ.* vol. viii. p. 282.—Kelch, *Beyträge zur pathologischen Anatomie*, 1813, p. 34, Berlin.—We have also seen this anomaly.

† Rosenmüller, *var. musc.* p. 5.—Kelch, *loc. cit.* p. 35. We have seen this variety also.

II. LEVATOR ANGULI SCAPULÆ.

§ 1007. The *levator anguli scapulæ* muscle, *Trachelo-scapulaire* Ch. (*M. levator scapulæ*, s. *angulæ*, *M. patientiæ*) is situated behind and on the side of the neck, over the rhomboidei muscles. It is longer, but thicker and more rounded than these muscles. It arises from the posterior tubercle of four, and more rarely of three or five, of the upper cervical vertebræ, by as many digitations, which are at first tendinous, generally very long, and which, especially the first, remain distinct through the whole length of the muscle. These digitations, the first of which is much the strongest, unite in a common belly, which descends obliquely backward and outward, and is attached by short tendinous fibres to the upper angle of the scapula. It is rare to find only two digitations which are attached to the first two vertebræ; however we have once observed this arrangement which was perfectly symmetrical on both sides; at the same time, the levator scapulæ was completely divided into two muscles, an internal above, an external below; the latter was inserted in the commencement of the spine.

This formation is similar in more than one respect to what is seen in animals: in fact, in most mammalia, the levator anguli scapulæ muscle has but two or three digitations, which are always attached to the upper cervical vertebra, seldom to the occipital bone. On the other hand, in apes this muscle is inserted into the spine of the scapula, and in the dolphin covers the surface of this bone.

Its upper tendons are blended with those of the splenius colli and of the cervicalis descendens. In its course it lies above the splenius muscle and is covered below by the trapezius.

This muscle corresponds in its situation and its action to the rhomboidei muscles, of which we recognize that it is only a repetition when we find it divided into several bellies, each of which is attached to but one vertebra.

It draws the upper angle of the scapula upward, but at the same time turns it round its axis, and depresses the region of the shoulder when it acts alone; so that it is the antagonist of the trapezius and serratus magnus muscles. When it contracts at the same time with the rhomboidei and trapezius, the shoulder is directly elevated. When the upper extremities are fixed, it draws the neck to its side, if only one muscle acts; but if both contract, the neck is fixed and kept straight.

§ 1008. Sometimes a long slip is detached from this muscle, which goes between the scapulæ and the vertebral column, an arrangement similar to what is seen in the dolphin.

III. SERRATI MUSCLES.

§ 1009. The *posterior serrati* muscles (*M. serrati*, s. *dentati postici superior et inferior*) form in fact but a single muscle, since they are united

by an aponeurotic expansion. Both arise from the spinous processes of the vertebræ, and are attached to the ribs. The inferior is covered by the latissimus dorsi, the upper by the trapezius and the rhomboidei muscles; both are broad and thin. They are both square, and are attached by several digitations to the ribs.

A. SERRATUS POSTICUS SUPERIOR.

§ 1010. The *serratus posticus superior* muscle, *Dorso-costal*, Ch., usually arises by a broad tendon from the spinous processes of the last cervical and of the first and second dorsal, rarely also from the sixth cervical and from the third dorsal vertebræ. Its fibres are directed obliquely downward, and divide most frequently into four and more rarely into three digitations, which are attached to the upper edge and to the external face of the second, third, fourth, and fifth ribs, a little beyond their angle.

§ 1011. Sometimes a single head leaves the upper part of this muscle, ascends along the levator anguli scapulæ muscle, and goes to the transverse process of the first cervical vertebra.*

B. SERRATUS POSTICUS INFERIOR.

§ 1012. The *serratus posticus inferior* muscle, *Lombo-costal*, Ch., is broader but thinner than the superior. It arises by a very broad but thin tendinous expansion from the spinous processes of the last two dorsal and the first three lumbar vertebræ, and adheres to the posterior tendon of the latissimus dorsi muscle so intimately that it may be said in fact to come from it. Its fibres have the same direction as that of the tendon, that is, they descend obliquely from behind and downward, and are attached, usually by four digitations, to the inferior edge of the last four ribs before their angle, from which they separate still more as they are lower, so that the upper in some measure cover the lower.

Between these two muscles is an elongated, very thin, aponeurotic expansion (§ 1009), in the tissue of which we evidently perceive transverse fibres in one part and another, but especially at its upper and lower parts: this expansion arises from the spinous processes of the dorsal vertebræ situated between the two muscles, and is attached to the angle of the ribs.

§ 1013. The two muscles form, with the aponeurosis which unites them and the bones placed before them, a kind of canal, in which are situated the subjacent dorsal muscles, which are compressed and kept in place by their simultaneous action. The upper raises the ribs to which it is attached. The lower acts with more power, because the ribs in which it is inserted are less firmly fixed, and it draws them downward and outward. These two muscles assist in inspiration, and are not antagonists.

* Rosenmüller, *loc. cit.* p. 5.

IV. SPLENII MUSCLES.

§ 1014. The *splenii* muscles (*M. splenii*) are considered by many anatomists as forming only one muscle, because their two lower extremities are so intimately connected. But the proportionally small extent of their union makes it more convenient to regard them as two separate muscles, one of which however is a repetition of the other: the lower is the *splenius colli*, the upper the *splenius capitis*. Both are situated directly under the trapezius, and go, from below and inward, upward, forward, and outward. They are elongated, flat, and thin. They occupy the space between the spinous processes of the lower and the transverse processes of the upper vertebræ, or of the corresponding bones.

A. SPLENIUS COLLI.

§ 1015. The *splenius colli* muscle, *Dorso-trachelien*, Ch., arises, by short and tendinous fasciculi which are not very deeply separated, from the spinous processes of the third, fourth, and fifth dorsal vertebræ. It is attached by two, rarely by three, other longer digitations to the extremities of the transverse processes of the two, rarely of the three, upper cervical vertebræ.

B. SPLENIUS CAPITIS.

§ 1016. The *splenius capitis* muscle, *Cervico mastoidien*, Ch., is broader and stronger than the preceding, and is situated immediately above it; hence its lower edge is attached to the upper edge of the other. It arises, by short tendons, from the cervical ligament at the side of the spinous processes of the third, fourth, fifth, and sixth cervical vertebræ, rarely also of the second, from the spinous process of the last cervical vertebra, and more rarely from those of the upper two dorsal vertebræ, and is attached to the posterior part of the mastoid process in its whole extent, where it covers the sterno-cleido-mastoideus muscle, and to the external part of the asperity situated below the upper curved line of the occipital bone, and consequently to a part of the bones of the skull which corresponds to the transverse processes of the vertebræ.

§ 1017. The splenius colli muscle turns the neck, and the splenius capitis turns the head, so as to carry the face to the opposite side. At the same time they incline these parts a little backward; and when they have been turned from the opposite side, they render them straight.

ARTICLE THIRD.

MUSCLES OF THE THIRD LAYER.

§ 1018, The third layer comprises the sacro-spinalis, the cervicalis descendens, the biventer cervicis, the complexus, the trachelo-mastoideus, and the transversalis colli muscles which are attached to the ribs and head, and have all an oblong form.

I. SACRO-SPINALIS.

§ 1019. The *sacro-spinalis* muscle, the largest of all these muscles, extends almost the whole length of the vertebral column. It fills most of the channel between the spinous processes and the transverse processes of the vertebræ and the ribs, and divides into two bellies, which are united below to a considerable extent. The external belly is called the *sacro-lumbalis* muscle, and the internal the *longissimus dorsi* muscle.

The common belly, which is considerably thick, arises from the upper, inner, and posterior part of the crest of the ilium, from the upper oblique and spinous processes of the sacrum, from the posterior sacro-iliac ligament, where it unites with the glutæus maximus muscle, from the spinous processes of all, or only from the lower four of the lumbar vertebræ, and besides from each lumbar vertebra by short digitations the external of which is attached to almost all the transverse process, and the internal to the *accessory process* (*processus accessorius*) of the latter. Its external part is fleshy. The internal is entirely tendinous at its lower part, but only on the surface at its upper. The tendon is very strong and dense, especially where it comes from the spinous processes of the lumbar vertebræ.

This common belly extends to the twelfth rib, where it divides to form the two muscles above mentioned. These gradually become thinner as they ascend, and divide into a great many slips.

The *longissimus dorsi* muscle is attached, 1st, by twelve bands, which grow shorter as they ascend, to the extremities of the transverse processes of the dorsal vertebræ; 2nd, farther outward, by seven or eight shorter, weaker, closer, broad slips, to the posterior and smooth face of the necks of the corresponding lower ribs.

The *sacro-lumbalis* muscle, the outer belly of the sacro-spinalis muscle, receives in its course several accessory fasciculi which may be considered so many origins. These fasciculi arise by tendinous fibres from the angles of the twelve ribs. Their form is oblong, and they become longer and thinner the higher they are; they go a little upward and outward. Arising from all these points, the muscle is, attached by thirteen slips, which gradually diminish in length from above downward, 1st, to the inferior edges of the angles of the ten or

leven lower ribs, and to the upper edge of the angle of the first or of he two upper ribs, near their tubercles ; 2nd, by the thirteenth slip, vhich is the uppermost, to the transverse process of the last cervical ertebra.

The two bellies extend the trunk, prevent it from bending forward, ncline it backward and a little to the side, and draw the ribs downward.

II. CERVICALIS DESCENDENS.

§ 1020. The *cervicalis descendens*, more properly *ascendens* muscle, only, strictly speaking, the upper part of the sacro-lumbalis muscle. t arises from the angle of the third, fourth, fifth, and sixth ribs, by ree or four longitudinal slips which correspond to the accessory sciculi of the sacro-lumbalis muscle, and unite in a short, thin belly. his usually divides into four, sometimes only three or even two digi- tions, which gradually increase in volume from below upward.

These digitations are attached to the posterior roots of the transverse ocesses of the third, fourth, fifth and sixth cervical vertebræ.

It draws the neck backward, and inclines it a little to the side. hen the neck is fixed, it slightly raises the ribs.

III. BIVENTER CERVICIS.

§ 1021. The *biventer cervicis* muscle* is situated very near the edian line, and is mostly covered by the splenii muscles, which tirely conceal it, except at its upper and lower extremities. It ex- nds from the centre of the pectoral portion of the vertebral column the occipital bone. It is an elongated and thin muscle composed of o rounded bellies, and of a central tendon nearly as long as the two llies. The upper part of its external edge blends intimately, espe- lly by the tendon of the upper belly, with the complexus muscle uated at its side.

The lower belly arises by from two to five fasciculi, the inferior of ich are the longest and thinnest, from the posterior face of the nsverse processes of the second, third, fourth, fifth, sixth, seventh, d eighth dorsal vertebræ.

It usually blends with the longissimus dorsi muscle by one of the erior fasciculi, or by a distinct muscular band. Its lower extremity onstantly united with the heads of the transversalis colli muscle, and t generally with the lower extremity of the trachelo-mastoideus scle.

These fasciculi, situated one above another, so that the posterior er the anterior, unite to the inferior belly, which terminates im- ceptibly in a point at its summit, and which almost always sends ng the inferior face of the central tendon, a thin muscular slip ich extends to the upper belly.

This central tendon, which, from its situation, is much longer, and e apparent on the posterior face of the muscle, the only place,

* The long portion of the complexus muscle of most anatomists.

properly speaking, where it is entirely loose; commences nearly opposite the third dorsal, and extends as high as the fifth cervical vertebra.

The upper rounder belly is stronger and longer than the lower, and enlarges at its upper extremity, and is thinner in this part than the rest. It becomes a short tendon upward, by which it is attached to the inner part of the upper curved line of the occipital bone.

Sometimes, and even usually, this muscle has three bellies, because the upper belly at the point of union with the tendon of the complexus muscle, is divided into two portions, an upper larger, a lower smaller, by a tendon which is often an inch long, and which is likewise seen on its posterior face.

Usually also we see one of the three fasciculi coming from the spinous process of the last cervical, or of the first dorsal vertebra, sometimes also from the fifth and the sixth cervical vertebræ, to go to the internal edge of the upper belly, a little above its lower extremity.

This muscle extends the neck, keeps it straight, and brings it backward. When it acts with its fellow, it extends it backward.

IV. COMPLEXUS.

§ 1022. The *complexus* muscle is situated at the side of the preceding, and should be regarded as its external portion.* It is broader and stronger, but shorter than it, and generally extends only from the third cervical vertebra to the occipital bone. Its form is an oblong and irregular quadrilateral.

It arises by from six to nine fleshy heads, which are very tendinous at their lower part, of which an inferior is deficient more frequently than a superior; these arise from between the third cervical and the fifth dorsal vertebræ. The three or four lower heads arise from the upper and external parts of the transverse processes; the others more internally, from the articular processes; so that each of the latter arises from two successive vertebræ. All ascend obliquely, the inferior straighter than the others towards the spinous processes and the biventer cervicis muscle, and unite in a large fleshy belly, in which we can always trace the fasciculi of the heads which form it.

We perceive a little above the centre of this belly an intermediate tendon, more or less perfect, and usually stronger at its internal part; which unites by this part with the second intermediate tendon of the biventer cervicis muscle, and which is also more apparent on its external than on its internal face.

The complexus muscle is attached by very short tendinous fibres which form a broad, single, rounded, and convex edge, to the external part of the upper curved line of the occipital bone.

* This muscle and the preceding, are described by Chaussier, as the *trachelo-occipital*. F. T.

Its uses are the same as those of the preceding muscle, but it draws the head more obliquely to its side when it acts alone.

§ 1023. A thin accessory muscle sometimes arises from the transverse process of the second dorsal vertebra, ascends towards the head, and is attached to the occipital bone between the complexus and the rectus posticus muscles. This formation is remarkable as being analogous with the formation of birds.

V. TRACHELO-MASTOIDEUS.

§ 1024. The *trachelo-mastoideus* muscle, *Trachelo-mastoidien*, Ch., (*M. trachelo-mastoideus*, s. *mastoideus lateralis*, s. *complexus parvus*), is next on the outside of the complexus muscle, is by no means as powerful, and, strictly speaking, should not be separated from the transversalis colli muscle, being in fact its internal and upper part.

It arises by from one to seven heads, of which a superior is deficient more frequently than an inferior. It extends from the third cervical to the sixth dorsal vertebra, arising by its lower heads from the upper part of the outer extremities of the transverse processes and from the oblique processes by its upper heads, and is here intimately united with the origin of the biventer cervicis, the complexus and the transversalis colli, and most generally at its lower part with the longissimus dorsi muscle. These heads unite in a thin muscle which ascends along the anterior edge of the complexus muscle, and its upper extremity is attached to the posterior edge, and to the lower extremity of the mastoid process of the temporal bone.

This is the usual arrangement: but sometimes this muscle is divided to two bellies by a long intermediate tendon. Sometimes its upper part is separated into two and even three slips, the lower of which are attached to the transverse processes of the first and even of the second cervical vertebra.

It flexes the neck, which it inclines obliquely to its side, making the head lean a little in the same direction.

VI. TRANSVERSALIS COLLI.

§ 1025. The *transversalis colli* muscle is situated on the outside of the preceding, and is sometimes closely united with it and sometimes separated from it in a very inconstant manner. It extends between the first cervical and the middle and even the inferior dorsal vertebræ.

It arises by five, six, or seven heads from the transverse processes of the upper eight dorsal and the lower three cervical vertebræ; so that the upper heads are deficient more frequently than the lower.

Usually it is not situated so high, does not arise so low, and is attached by four or five upper heads to the extremities of the posterior roots of the transverse processes of the first six cervical vertebræ, though generally it does not extend to the first.

Its size, the number of slips of its origin and insertion, are opposite to those of the trachelo-mastoideus muscle in all these respects, if we would consider it a muscle distinct from the last.

It extends the neck and inclines it a little backward.

ARTICLE FOURTH.

FOURTH LAYER OF MUSCLES.

§ 1026. The fourth layer comprises numerous muscles, all of which are situated between the vertebræ or between these bones and the head. Those between the different vertebræ are the semispinalis cervicis, the semispinalis dorsi, the spinalis dorsi, the multifidus spinæ, the interspinales, the supraspinales, and the intertransversarii; those situated between the upper vertebræ and the head are the recti muscles, the obliqui muscles, and the rectus capitus lateralis muscle.

I. DORSAL MUSCLES OF THE FOURTH LAYER.

A. SEMISPINALIS COLLI.

§ 1027. The *semispinalis colli* muscle* arises by five or six heads, the inferior of which are the longest, feeblest, and straightest from the posterior face of the extremities of the transverse processes of the five or six upper dorsal vertebræ. It extends obliquely upward and inward, and is attached by four separate heads to the lower edge of the tubercles of the spinous processes of the second, third, fourth, and fifth cervical vertebræ.

It extends the neck and inclines it a little obliquely backward.

B. SEMISPINALIS DORSI.

§ 1028. The *semispinalis dorsi* muscle resembles the preceding in form and situation. It arises by six or seven inferior heads from the posterior faces of the transverse processes of the fifth, sixth, seventh, eighth, ninth, tenth, and eleventh dorsal vertebræ, goes obliquely upward and inward, and is attached by five or six separate slips to the lower edge of the summit of the spinous processes of the lower two cervical and the three or four superior dorsal vertebræ.

These two muscles should be considered as one, and their separation is purely artificial.† When united, they correspond to the complexus and to the biventer cervicis muscle.

* This muscle is generally termed the *spinalis colli* muscle: but this term should be rejected, because then its analogy with the following muscle, of which it is the continuation, is neglected. Albinus noticed this fact.—*Hist. musc.* p. 381.

† Albinus' remark upon these muscles is generally correct:—"With which (the spinalis) it is sometimes so blended, that it is doubtful to which the proximate heads and extremities belong."—*Hist. musc* p. 382.

The semispinalis dorsi resembles the preceding in its action on the back and lower part of the neck.

C. SPINALIS DORSI.

§ 1029. The *spinalis* muscle, usually called the *spinalis dorsi* muscle, can never be presented as a distinct muscle, being always blended with the longissimus dorsi, the multifidus spinæ situated below, and the semispinalis dorsi muscles. It rests directly on the upper and posterior parts of the arches of the vertebræ, and arises by four or five separate heads from the lateral faces of the spinous processes of the upper two lumbar and lower two or three dorsal vertebræ. These heads remain for a long time tendinous. The middle belly soon divides into from four to eight upper heads, which are attached to the lateral faces of the spinous processes of the upper dorsal vertebræ.

This muscle represents particularly the digitations of the biventer cervicis muscles, which are usually attached to one or some of the spinous processes of the lower cervical vertebræ.

It extends the vertebral column and inclines it to its side.

D. MULTIFIDUS SPINÆ.

§ 1030. The *multifidus spinæ* muscle is formed by a great many fleshy bands, which extend obliquely downward from the transverse processes to the spinous processes of the vertebræ above, and which interlace so differently that they thus give rise to a muscle. This muscle forms the last layer of the muscles of the back and neck, and fills the inner and deepest part of the hollow between the transverse and spinous processes.

The highest slip is attached by its upper extremity to the spinous process of the second cervical vertebra, and the lowest slip is inserted the transverse processes of the fourth and fifth vertebræ of the sacrum.

The muscle becomes considerably thinner as it ascends, and in the same proportion less fleshy but more tendinous. The lower its fibres are more perpendicular its direction.

It is united more or less intimately with the spinalis and the semispinalis dorsi and colli muscles. Taken as a whole with these three muscles, it represents for the rest of the vertebral column and for the vertebræ the biventer cervicis and the complexus.

It extends the vertebral column and moves it to one side.

E. INTERSPINALES.

§ 1031. The *interspinales* muscles are short muscles formed of longitudinal fibres, which are situated between the summits of the spinous processes of two adjacent vertebræ.

The most apparent are those of the cervical vertebræ. Those of the lumbar vertebræ are the most feeble. Those of the dorsal vertebræ

are the least distinct and often partially deficient. The cervical, as their spinous processes enlarge, become doubled more frequently than in the other regions, and thus divide into two separate muscles, a right and a left.

§ 1032. We sometimes find in the neck *supraspinales* muscles (*M. interspinales supernumerarii*, s. *supraspinales*), which are more superficial than the preceding and which sometimes pass over several vertebræ. Thus we sometimes find in the same subject thin and small muscles, which pass from the summits of the transverse processes of the sixth or seventh to the corresponding parts of the second cervical vertebra, and below them other feebler muscles, which go from the seventh to the third cervical vertebra: both exist either on one or on both sides. These supraspinales muscles are sometimes shorter.

According to our dissections, the supraspinales muscles exist more frequently than they are absent. They evidently correspond to the spinalis dorsi muscle (§ 1029); so that they would be more properly termed the *spinalis cervicis* muscles. They are generally situated on the summits of the spinous processes and not on their sides. Their presence in the neck is remarkable as an analogy with the rectus capitis posticus major muscle, which normally passes over the first cervical vertebra.

They are always looser and more detached than the fleshy slips which compose the spinalis colli muscle, in which they resemble the type of the other muscles of the neck and of the cervical vertebræ.

They extend the vertebral column.

F. INTERTRANSVERSARII.

§ 1033. The *intertransversarii* muscles are formed of longitudinal fibres and are situated between the transverse processes of two vertebræ. In the cervical region they are double, like the interspinales muscles, and are called the *anterior* and *posterior*: the former extend between the anterior roots and the latter between the posterior roots of two transverse processes.

They incline the vertebral column to the side.

II MUSCLES OF THE FOURTH LAYER BELONGING TO THE HEAD.

§ 1034. The muscles of the fourth layer belonging to the head perfectly resemble in their essential character those muscles of the same layer which belong to the back or those of the layers over them, and are more largely developed only from the weight which they are obliged to move. They are imbedded in loose cellular tissue, which separates them from each other and from the muscles below.

They are the two straight, two oblique, and one lateral muscle.

A. POSTERIOR RECTI MUSCLES OF THE HEAD.

§ 1035. The two recti muscles of the head (*M. capitis recti*) correspond to the interspinales muscles, and are in fact the two superior. The transition from them to the latter is marked by the interspinales colli muscles, which are strongest and in pairs, and also by the supraspinales muscles (§ 1032), which are often seen.

a. Rectus capitis posticus major.

§ 1036. The *rectus capitis posticus major* muscle, *Axoido-occipital*, Ch., (*M. capitis posterior rectus major*, s. *superficialis*, s. *epistrophico-occipitalis*), is triangular and arises from the upper face of the spinous process of the second cervical vertebra. It begins below in a point, enlarges very much at its upper part, passes above the arch of the atlas and over the rectus capitis posticus minor muscle, and is attached by a thin and rounded edge to the lower curved line of the occipital bone.

§ 1037. This muscle not unfrequently occurs double, and this excess is analogous to the normal formation in the ruminating animals and in birds.

It extends the head directly backward.

b. Rectus capitis posticus minor.

§ 1038. The *rectus capitis posticus minor* muscle, *Atloido-occipital*, Ch., (*M. posticus capitis minor*, s. *profundus*, s. *atlanto-occipitalis*), arises from the spinous process of the first cervical vertebra, and is attached to the internal part of the lower curved line and also to the rough surface below, between it and the posterior edge of the large occipital foramen. It is triangular like the former, but much broader in proportion to its length. Its summit is likewise turned downward.

This muscle acts like the preceding, but is less powerful, from its smallness and its unfavourable insertion.

These two muscles represent the upper two spinales colli muscles. The rectus major muscle corresponds to the second, which, from the great weight it moves, passes by the first vertebra and is attached to the corresponding part of the occipital bone. The rectus minor corresponds to the first; it is not an exception to the rule.

B. OBLIQUE MUSCLES OF THE HEAD.

a. Obliquus capitis inferior.

§ 1039. The *obliquus capitis inferior* muscle, *Axoido-atloidien*, Ch., the strongest of the small muscles of the head, and has an oblong

quadrilateral form. It arises below and on the outside of the rectus capitis major muscle (§ 1035), from the lateral face of the spinous process of the second cervical vertebra, goes obliquely upward, outward, and forward, and is attached to the posterior face of the extremity of the transverse process of the first cervical vertebra.

It moves the neck and at the same time the head, which it rotates on their axes; so that the face is turned toward the side of the muscle which contracts.

This muscle seems to be the external part of the second spinalis colli muscle largely developed, the upper extremity of which would proceed to the next vertebra, as do all the other spinales muscles, but it goes more externally on account of the turning of the head. Farther, we may compare it to the splenii muscles of the preceding layer, for it resembles them perfectly in its insertions, direction, and uses.

b. Obliquus capitis superior.

§ 1040. The *obliquus capitis superior* muscle, *Atloido-sous-mastoidien*, Ch., is triangular. It arises above the preceding, from the upper face of the summit of the transverse process of the first cervical vertebra. It goes obliquely upward and inward, enlarges, and is attached to the occipital bone on the external part of the rough surface in the space between the two ridges.

It draws the head backward and a little to the side, so as to bring it near the occiput and turn the face from the opposite side; hence it is the antagonist of the preceding muscle.

We may consider it as a part of the upper intertransversarius cervicis muscle or as the upper and posterior part of the second interspinalis muscle, and consequently as the upper part of the preceding. This similarity however is still greater if we compare it to the upper slip of the multifidus spinæ muscle, the deficiency of which as stated by most anatomists will be compensated for in this manner.

C. RECTUS CAPITIS LATERALIS.

§ 1041. The *rectus capitis lateralis* muscle, *Atloido-sous-occipital*, Ch., is the smallest in this region, and arises from the upper part of the transverse process of the first cervical vertebra, goes forward and outward, and is attached to an impression in the occipital bone behind the posterior edge of the foramen lacerum.

It draws the head to the side and a little forward.

It evidently wholly or partially represents the posterior intertransversarius cervicis muscle, which is here larger and goes a little farther forward.

This muscle is sometimes double, an arrangement normally seen in birds.

ARTICLE FIFTH.

ACCESSORY MUSCLES OF THE FOURTH LAYER.

§ 1042. We may also for the convenience of study refer to this fourth layer of the dorsal muscles the levatores costarum, the scaleni, the quadratus lumborum, and the intercostales muscles, and oppose them to the preceding as being accessory muscles, from the analogy of the bones of the trunk.

I. LEVATORES COSTARUM.*

A. LEVATORES COSTARUM BREVES.

§ 1043. Each rib has a short levator muscle. These muscles (*levatores costarum breves*) are triangular: they arise from the inferior edge of the summit of the transverse process of the next superior dorsal vertebra, go obliquely downward and outward, gradually enlarge in their course, and are attached to the posterior and superior edge of the portion of the ribs comprised between the tubercle and the angle, but they do not extend to the latter.

They are mostly tendinous on their posterior face.

B. LEVATORES COSTARUM LONGI.

§ 1044. Besides, the three to five inferior ribs have long levators (*levatores costarum longi*), which are also triangular, but broader, situated more externally, and more superficially than the short. They arise near the summit of the transverse processes of the inferior dorsal vertebræ and pass over one rib to be attached to the following.

The long and short levators of the ribs are uninterruptedly continuous with the external intercostal muscles.

The action of these muscles is indicated by their name.

II. SCALENI.

§ 1045. The *scaleni* should be called the long levators of the upper ribs, for they resemble the preceding in situation and form, although they act less on the ribs than upon the cervical vertebræ.

Their general characters are: 1st, they are oblong, triangular, and pointed at their two extremities; 2nd, they arise from the upper edge and from the external face of one or both of the two upper sides by a single

* The levatores breves and longi are sometimes termed collectively the supracostales muscles.

broad tendon; 3rd, they are attached to the transverse processes of several cervical vertebræ by different tendinous bands; 4th, they flex the neck to the side and raise the ribs. Their number is not always the same, and varies from three to six. The most constant and the largest are three in number; the *anterior*, the *lateral* or *middle*, and the *posterior*.

A. SCALENUS ANTICUS.

§ 1046. The *scalenus anticus* muscle, *Costo-trachelien*, Ch., is situated behind and below the sterno-cleido-mastoideus muscle. It arises from the upper face of the first rib, some distance behind its anterior extremity, goes upward and backward, and terminates in two, three, or four bellies, which are usually separated only at their upper part, and are attached to the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ.

B. SCALENUS MEDIUS.

§ 1047. The *scalenus medius* muscle, the longest of all, arises from the first and second ribs, about an inch farther backward and outward than the preceding, goes directly from below upward, and is attached most generally by seven slips to the posterior tubercles of the transverse processes of the seven cervical vertebræ.

C. SCALENUS POSTICUS.

§ 1048. The *scalenus posticus* muscle, the shortest of all, arises much farther back than the others, from the posterior part of the external face of the second rib, goes obliquely upward and forward, and is attached, behind the two preceding by two and rarely by three long and tendinous slips, to the posterior extremities of the transverse processes of the fourth, fifth, and sixth cervical vertebræ. It is sometimes deficient.

D. SUPERNUMERARY SCALENI MUSCLES.

§ 1049. The *unusual* or *supernumerary scaleni* muscles are usually developed between those already described and are smaller than them. An *anterior*, which is situated between the scalenus anticus and medius, and is sometimes called the *Scalenus minimus*, Albinus, is sometimes formed by the division of the anticus, since it is situated directly behind it and comes from the first rib. It is attached by one, two, or three heads to the anterior extremity of the transverse processes of the fifth, sixth, and seventh cervical vertebræ. Usually, the inferior nerves of the brachial plexus and the axillary vessels pass along its posterior face, between it and the scalenus medius, and the upper nerves along its anterior face, between it and the scalenus anticus muscle, although when this muscle is deficient they all pass between the scalenus anticus and medius.

This supernumerary scalenus anticus muscle often forms a more distinct muscle, being still more remote from the anticus and arising farther behind the upper face of the first rib. It is then always shorter, and is attached only to the summit of the transverse process of the sixth cervical vertebra, or of this and the fifth.

We have sometimes found it double. In this case there is an *external* and an *internal*, the former situated behind and the second before the last two nerves of the brachial plexus. The external or posterior is attached by a double upper slip to the anterior and posterior tubercle of the transverse process of the sixth cervical vertebra; and the internal or anterior is inserted by four slips placed above each other only in the anterior tubercles of the transverse processes of the fifth and sixth cervical vertebræ.

The supernumerary scalenus lateralis or posticus muscle is situated between the scalenus medius and the scalenus posticus. It arises from the posterior part of the first rib, and is attached between the slips of these muscles to the summits of the transverse processes of the fourth, fifth, and sixth cervical vertebræ.

We have sometimes found these three supernumerary scaleni at once in the same subject.

§ 1050. It is more unusual to find an analogous muscle coming from the transverse process of the sixth cervical vertebra and inserting itself into the inferior face of the humeral extremity of the clavicle.*

III. QUADRATUS LUMBORUM.

§ 1051. The *quadratus lumborum* muscle, *Ilio-costal*, Ch., is an oblong and rounded muscle, situated at the side of the lumbar vertebræ, between the posterior portion of the crest of the ilium and the twelfth rib, so that it forms in part the posterior wall of the abdomen.

It is composed of two more or less evident layers, an *anterior* and a *posterior*. The *posterior* layer is the most extensive. It arises from the inner lip of the iliac crest, a little behind its centre, and from the ilio-lumbar ligament by a broad tendon; becomes larger after arising, inclines inward toward the vertebral column, divides into five or six heads which are attached to the inferior portion of the extremities of the transverse processes of the three or four upper lumbar vertebræ and to the lateral portion of the bodies of the two inferior dorsal vertebræ, and is finally inserted by a broad slip in the inner part of the inferior edge of the twelfth rib.

The *anterior* layer is thinner, and arises by some tendinous slips from the upper part of the extremities of the transverse processes of the three or four inferior lumbar vertebræ, and blends with the preceding.

* Kelch, *Beytræge zur pathologischen anatomie*, p. 32, No. xxxiv.

The quadratus lumborum muscle evidently represents the levatores costarum, the scaleni, the levator anguli scapulæ, and the rhomboidei muscles; and anteriorly, the pyramidal muscles. We must not compare this muscle, but the two obliqui abdominis muscles, to the intercostales muscles. The two layers of which it is composed fully justify the parallel drawn between it and the preceding muscles.

It flexes the lumbar vertebræ to its side, and depresses the lower ribs.

IV. INTERCOSTALES.

§ 1052. The *intercostales* muscles are divided into the proper intercostales and the subclavius muscles.

I. PROPER INTERCOSTALES.

§ 1053. Each intercostal space is filled on each side by two thin muscular layers formed of oblique fibres, which are called the *intercostales* muscles. The whole number of these muscles is consequently forty-four, of which eleven on each side are external, and eleven internal.

a. Intercostales Externi.

§ 1054. The *intercostales externi* muscles, go from the lower part of the external face of the ribs, obliquely from behind forward, to the upper part of the outer face of the next rib below, so that their posterior fibres are more oblique than their anterior. They commence near the tubercle of the ribs, and extend to the costal cartilages. At their termination, they are replaced by an aponeurosis formed of fibres which have the same direction. Many tendinous fibres leave their upper and lower edges, and are expanded on their external face, which extend almost to the opposite edge.

b. Intercostales Interni.

§ 1055. The *intercostales interni* muscles occupy all the space between the costal cartilages and the bony parts of the ribs to their angle. Their fibres are oblique from within outward, and from before backward, and extend from the internal margin of the inferior edge of each rib to the internal lip of the upper edge of the rib directly below.

The inferior, at their posterior part, occasionally give off slips which pass to the next rib, and even to the one below.

The central are divided by slips, situated between each pair of costal cartilages, into two portions; an *anterior*, which is smaller, and a *posterior*, which is larger.

They differ from the intercostales externi muscles because they extend farther forward, and not so far backward; because they are not so broad, and because their fibres, which follow a contrary direction, are straighter.

The two layers of intercostal muscles approximate the ribs to each other, and usually raise the lower ribs which are more movable, to the superior, which are less so.

§ 1056. We also remark on the internal face of the cavity of the thorax, muscular fasciculi, which are not constant, have no fixed place, vary much in size, sometimes lean to one side, and may be called the *infracostales* muscles. Kelch has described them as the internal serrati muscles.*

II. SUBCLAVIUS.

§ 1057. The *subclavius* muscle, *Costo-claviculaire*, Ch., resembles the intercostales, especially the externi, in situation and uses.

It arises by fleshy fibres, which descend obliquely downward and outward from the greater external part of the inferior face of the clavicle, and from the outer part of the anterior face of the rhomboid ligament; and it is attached by a strong tendon, which extends along its inferior edge to the anterior face of the cartilage of the first rib, not far from its anterior extremity.

It brings the clavicle towards the first rib, which it most generally draws downward; but it can also act in an opposite direction, and approximate the rib to the clavicle.

§ 1058. The analogy between the subclavius and the intercostales muscles, is sometimes rendered more evident by the presence of a second subclavius muscle, which arises from the coracoid or the acromion process, and is attached to the first rib.† This anomaly indicates the relation between the subclavius and the pectoralis minor muscles, and connects the normal state with that in which we find a third accessory muscle.

CHAPTER II.

ANTERIOR MUSCLES OF THE TRUNK.

§ 1059. The anterior muscles of the trunk comprise the muscles of the abdomen and chest, the anterior muscles of the neck, and the muscles of the sacrum coccyx, when they exist.

* *Beitr. zur. Path. Anat.*, p. 41. No. 32.

† Bohmer, *Obs. Anat.*, part I. p. 4. - Rosenmüller, in Isenflamm and Rosenmüller, *Beit.*, vol. i., p. 375, and *De nonnullis musc. corp. humani varietatibus*, p. 6.

ARTICLE FIRST.

OF THE ABDOMINAL MUSCLES.

§ 1060. We find in the abdominal region seven pairs of muscles which form its parietes; four are broad, two are long, and one is short.

§ 1061. The four broad muscles are the obliquus externus, the obliquus internus, the transversalis, and the diaphragm. The two long muscles are the rectus abdominis and the pyramidalis. The short muscle is the quadratus lumborum (§ 1051). This latter has already been described.

Among the broad muscles, the first three are situated before and on the sides of the abdominal cavity, while the diaphragm occupies the upper and posterior part: the two long muscles belong to the anterior wall, and are situated on the median line.

I. OBLIQUUS EXTERNUS ABDOMINUS.

§ 1062. The *obliquus abdominis externus* or *descendens* muscle, *Costo-abdominal*, Ch., is situated directly under the skin. It covers not only the other two broad abdominal muscles, but also the anterior part of the inferior intercostales and the last eight ribs, on the anterior face of which it is placed.

Its posterior part is fleshy, and its fibres go obliquely downward, inward, and forward. It arises from the last eight ribs by eight slips, the extremities of which are tendinous, and which are blended with the pectoralis major, the serratus major, and the latissimus dorsi muscles.

Of the eight slips which form the external edge of this muscle the upper is the thinnest, but the longest. It is united by the lower part of its anterior edge with the inferior part of the pectoralis major muscle, while the upper part of this same edge proceeds directly at the side of the lower part of the posterior edge of this muscle, and is attached to the external face of the fifth rib, about two inches behind its anterior extremity.

The second and third slips are the broadest. The fourth, fifth and sixth gradually become narrower; the seventh and eighth are much narrower than the others, with the exception of the first.

The eighth is attached not only to the cartilage of the last false rib, but also, by its lower part, to the common tendon of the two succeeding abdominal muscles. The whole posterior edge is oblique downward and backward, from the first slip to the last; in the rest of its extent, which is less, it follows an inverse direction, and goes obliquely downward and forward.

The four upper slips are so blended with the four lower slips of the serratus magnus muscle, and the four lower with those of the latissi-

mus dorsi muscle, that all these slips intercross with each other by tendinous edges, directed obliquely upward and inward.

The substance of the muscle becomes much thicker from above downward.

The inferior edge of the fleshy portion is attached by short tendinous fibres to the anterior half of the internal lip of the iliac crest. It terminates at the anterior and superior iliac spine. The anterior edge describes, inward and forward, two convexities, a superior which is shorter, and a posterior which is much larger, which are separated by an intermediate depression. It is continuous with the broad anterior tendon.

The fleshy part of the obliquus externus abdominis muscle represents an oblong rhomboid, the centre of which is the broadest portion and the upper part the narrowest.

The tendon of this muscle is as broad, but much higher than its fleshy portion, since it extends from the inferior edge of the pectoralis major muscle and the cartilage of the sixth rib to the symphysis pubis.

Its upper part is the weakest and thinnest, and it terminates upward in a straight edge, which corresponds to the median line; backward by another edge which is channeled in two places, a superior and an inferior. The anterior edge of its fleshy portion is attached to the latter. Its inferior edge is oblique from above downward. The superior is much shorter than the others and is attached to the anterior face of the cartilage of the sixth rib, and blends with the tendinous fibres of the pectoralis major muscle.

The internal is so intimately united with the same muscle of the other side that the fibres of both muscles extend in their whole extent a little beyond the median line.

The inferior is loose, and extends from the upper and anterior spine of the ilium to the symphysis pubis; its direction is consequently oblique from above downward and forward. It forms a kind of bridge, which is extended over the space which exists in this place between the crest of the ilium and the horizontal portion of the pubis. This inferior edge is very improperly called the *ligament of Fallopius* (*Lig. Fallopii*, s. *Pouparti*); it is more properly termed the *crural arch* (*arcus cruralis*).

Although the lower edge of the tendon of the obliquus externus abdominis muscle leaves the bones when it reaches the anterior and superior spine of the ilium, still it unites intimately an inch and a half farther, below and inward, with the outer part of the anterior face of the crural aponeurosis, and of the tendon of the fascia-lata muscle, which fixes it so firmly that the origin of the crural aponeurosis cannot be displaced except at the place were this union ceases. From its point of union with the aponeurosis of the thigh, fibres ascend, of which the internal particularly are very strong, and go to the anterior face of the tendon.

The *crural arch* is the thickest and strongest part of the tendon of the obliquus externus muscle. In its course, its turns slightly upward and inward, thus forming a channel or semicanal, in the anterior part of which the spermatic cord descends.

This semi-canal commences about an inch on the outside of the external angle of the inguinal ring, which we are about to describe. It is changed on the inside by the lower part of the obliquus internus and transversalis muscles into a canal, which descends obliquely, and may be called the *inguinal canal* (*canalis inguinalis*). This canal commences at the place where the spermatic cord in the male, and the round ligament of the uterus in the female, leave the abdominal cavity through the *superior*, *posterior*, or *abdominal* opening (*apertura canalis inguinalis superior, posterior*, s. *abdominalis*), and terminates by another *inferior*, *anterior*, or *external* opening (*apertura canalis inguinalis inferior, anterior, externa*), called also the *inguinal* or *abdominal ring* (*annulus abdominalis*).

From the posterior wall of the crural arch a thin layer arises, which is often formed by tendinous fibres, and is frequently simply cellular, called the *transverse band* (*fascia transversalis*)*. This band extends between the external face of the transverse muscle and the external face of the peritoneum. It strengthens, sustains, and limits the upper opening of the inguinal canal.

The connection between the aponeurosis of the thigh and the crural arch can be observed in no other place except the point above mentioned, and we may always demonstrate the loose and smooth edge which terminates it. Still a tendinous band, some lines broad, not unfrequently separates from the inferior edge of the tendon, being attached to it only by a condensed cellular tissue, and proceeds below and a little behind it, but in a parallel direction, and extends from the internal part of the upper extremity of the tendon of the tensor fasciæ-latæ muscle to the pubis, where it is attached to the internal part of the posterior face of its horizontal branch.

This band causes, to a certain extent, the crural arch to appear double, or it may be regarded as a special ligament which contracts the opening over it.

Below the crural arch the crural nerves and vessels pass out of the cavity of the abdomen to go upon the thigh, and are attached to it only by a very loose cellular tissue. The abdominal viscera follow the same route in *crural hernia*.

The tendon of the obliquus abdominis externus muscle is formed principally of fibres which descend obliquely inward. We however see on the whole of its anterior face other more feeble and less adherent fibres, which go in a contrary direction upward and inward, cross the preceding, and serve to increase the solidity of the tendon.

This tendon presents at its internal part a dozen rounded foramina,

*Cooper in Munro, *Morbid Anatomy of the human gullet, &c.*, p. 422.—See also J. Cloquet, *Recherches Anatomiques sur les hernies de l'abdomen*, Paris, 1817–1819.

situated one above another, and forming two series which are not arranged in pairs, but on the contrary alternate regularly. These openings are for the passage of the cutaneous vessels and nerves.

The lower part of this tendon presents a broader and more important foramen. This foramen is called the *inguinal* or *abdominal ring* (*annulus abdominalis*). It is an oblong and rounded opening, about an inch and a half long and an inch broad, the direction of which is oblique downward and inward, which is formed by the separation of the fibres of the tendon.

The opening in this place is only a greater development of the peculiar arrangement of the tendon of the obliquus externus muscle. In fact, when we examine this last attentively, we perceive that from the external and concave edge of the inguinal ring to the posterior edge of the tendon, and in a direction corresponding to that of the ring, thin fibres unite in fasciculi separated from each other, so that here and there the tendon is formed of weak external fibres, through which the colour of the subjacent muscles may be seen. The two fibrous fasciculi are called pillars; they immediately surround the inguinal ring, and the upper is generally in part separated from the rest of the tendon by two very considerable foramina, through which nerves and vessels pass. They are distinguished into the *upper* or *internal* and the *lower* or *external pilliar* (*crura annuli abdominalis superius*, s. *internum*, *et inferius*, s. *externum*). These are the thickest and strongest parts of the tendon. The lower pillar is stronger than the upper.

The upper pillar is broader and flatter than the lower and interosses with that of the opposite side, so that, the left usually covering most of the right, each is attached to the spine of the pubis of the opposite side, and is blended more or less intimately in this place with the fibres of the lower pillar of the other side.

The lower pillar is shorter and more rounded than the upper, and forms the true termination of the lower edge of the Fallopian tendon or ligament. It is slightly concave at its upper part, and forms a semicanal, which receives the lower part of the spermatic cord. It is attached for nine or ten lines by an edge, which is oblique from without inward and from behind forward, to the inner part of the horizontal branch of the pubis, as far as its spine.

The spermatic cord passes through the inguinal ring, following the direction of the greatest diameter of this foramen, and fills its lower portion. Many ascending fibres of the external layer, which are weaker and adhere less firmly to each other, go upon its anterior part.

The external portion of the tendon of the obliquus externus muscle is loose and united with that of the obliquus internus muscle, which is below it, only by a looser mucous tissue. The outer half of this part corresponds to the anterior region of the fleshy portion, and the inner part to the posterior edge of the tendinous portion of the obliquus externus muscle.

The smaller internal portion of the tendon unites very firmly with the tendon of the obliquus internus muscle, and forms with it the anterior layer of the sheath of the rectus abdominis muscle. This muscle is the most superficial and the largest of all the abdominal muscles which it covers almost entirely, except a small posterior and inferior part of the obliquus internus and transversalis muscles. It corresponds so much to the intercostales externi muscles in its position, in the direction of its fibres, and the slight distance to which its fleshy portion extends forward, that we are authorised to say that it represents them in the abdomen.

It draws the ribs downward, contracts the abdominal cavity in every direction, and in this manner it assists the other muscles in expelling the foreign bodies contained in it. At the same time, as the abdominal viscera acted upon by it tend to escape in every direction, it contributes immediately to compress the chest from below upward, and hence is a muscle of expiration. It assists a little to flex the vertebral column forward.

§ 1062. This muscle presents sexual differences in the form of the inguinal ring. In fact, in the male, where the large spermatic cord passes through it, the ring is broader and rounder than in the female, where it gives passage only to the thin round ligament of the uterus.

§ 1063. Besides the absence of a greater or less portion of its middle and anterior part, a defect of formation which is common to it with the other muscles of the abdomen in the fissure of the abdomen, the obliquus externus muscle is subject also to another anomaly, viz. the lower part of its anterior tendon is very imperfectly developed, is feeble, and presents numerous foramina. This anomaly depends on the absence of the external fibres which tie down and retain those of the deep layer. It results in a variety of external inguinal hernia, which resembles crural hernia because the viscera do not escape through the ring, but much more outward.*

II. OBLIQUUS INTERNUS ABDOMINIS.

§ 1064. The *obliquus internus abdominis* muscle, *Ilio-abdominal*, Ch. (*M. abdominis obliquus internus*, s. *obliquus ascendens*), is situated directly under the preceding, and forms the middle of three broad muscles of the abdomen. It is much smaller than the obliquus externus muscle, and occupies the space between the lower edges of the cartilages of the last five ribs, the crest of the ilium, the pubis, and the median line.

The direction of its fibres is directly opposite to that of the fibres of the obliquus externus muscle, for they proceed inward, forward, and upward. The posterior however are straight, the central very oblique, the internal, anterior, and inferior longitudinal, and the lowest of all

* Burns, in Munro, *Morbid anatomy of the human gullet*, &c., Edinburgh, 1811, p. 467.

oblique and descending downward and inward. Considered as a whole, it is then formed of fibres which are separated from each other like a fan.

The fleshy part of this muscle arises, by its upper edge, by short tendinous fibres from the whole inferior edge of the cartilage of the tenth and from the anterior part of those of the eleventh and twelfth ribs.

Its posterior edge unites with the posterior aponeurosis of the transversalis abdominis muscle, and with the common aponeurosis of the latissimus dorsi and of the serratus inferior posticus muscles, which aponeurosis arises from the spinous processes of the lumbar and sacral vertebræ.

It extends forward and downward much farther than the fleshy part of the obliquus externus muscle, and passes as far below it as the latter rises above it.

Its anterior edge is convex above, concave below; it extends from the summit of the cartilage of the tenth rib to near the symphysis pubis, terminates about half an inch above this articulation, and its direction is generally oblique downward and inward.

The inferior edge arises from the central face of the larger anterior part of the crest of the ilium, and below its anterior and superior spine, from the larger external part of the internal face of the crural arch. Its inferior fasciculi go very obliquely downward, pass out through the inguinal ring with the spermatic cord, which they surround externally, and descend with it into the scrotum: they form the *cremaster* muscle.

The tendon of the obliquus internus muscle is less extensive than that of the obliquus externus muscle; but from its origin it divides in the centre into two layers, an anterior and external, and a posterior and internal. The anterior layer is intimately blended with the tendon of the obliquus externus muscle (§ 1061), and forms the anterior wall of the sheath of the rectus abdominis muscle. The posterior layer unites in the same manner with the tendon of the transversalis muscle, and forms the posterior wall of the same sheath.

At its two extremities, on the contrary, the tendon is single, and formed only by the anterior layer which passes before the rectus muscle, and unites less intimately with the tendon of the obliquus externus muscle, especially below.

The upper edge of the tendon begins at the cartilage of the ninth rib; but the posterior layer disappears in the space between the seventh and eighth ribs. After leaving this point, the rectus muscle is situated directly on the tendon of the transversalis muscle, and higher on the costal cartilages.

The posterior layer of this tendon terminates downward, in the centre of the space between the umbilicus and symphysis pubis, by a semicircular edge, concave below, where its fibres separate a little from each other, and finally disappear.

The obliquus internus muscle corresponds to the intercostales

interni muscles (§ 1045), 1st, by the direction of its fibres; 2nd, by its situation below the obliquus abdominis externus muscle; and 3rd, because its fleshy fibres extend farther forward than those of the latter.

Like the preceding, it contracts the abdominal cavity in every direction, so that its effects are the same.

III. TRANSVERSALIS.

§ 1065. The *transversalis* muscle, *Lombo-abdominal*, Ch., (*M. abdominis transversus*, s. *internus*), much resembles the obliquus internus muscle in its extent and direction. Its fleshy part is however longer and narrower. The fibres which form it have a transverse direction; the direction of the lower fibres however is a little oblique from above downward and from behind forward.

The external edge is convex outward, and is oblique from above downward and from within outward. Most of it arises by seven broad fasciculi, which generally are not very distinct, from the internal face of the cartilages of the seven lower ribs, and is here blended with the anterior edge of the costal portion of the diaphragm.

The smaller and the inferior part of the posterior edge goes directly downward, and is attached to the anterior edge of the posterior tendon, to be described directly, which comes from the lumbar vertebræ.

The inferior edge is attached to the internal lip of the large anterior part of the crest of the ilium, and gradually unites, from the anterior and upper spine of the iliac bone to near the inguinal ring, with the inferior edge of the obliquus internus muscle; so that it also gives fibres to the cremaster muscle.

The anterior edge is very concave, especially directly below its centre. Its upper part is attached by short fibres to the lateral edge of the xyphoid cartilage, but in almost all its length it is attached to the anterior tendon. This latter is a little broader at its centre than that of the obliquus internus muscle; but it is much narrower above, because of the greater breadth of its fleshy portion.

It is composed almost wholly of transverse fibres, and forms the posterior layer of the sheath of the rectus muscle. This sheath does not extend the whole length of the muscle: it does not ascend to the same height, and is deficient on the costal cartilages which the recti muscles cover; it frequently terminates also downward, a little above the centre of the space between the umbilicus and the pubis; but we generally find in this place a very thin tendinous expansion, to which the lower part of the anterior edge of the transversalis abdominis muscle is attached, and which sometimes passes behind the rectus muscle, to unite beyond its internal edge to the anterior layer of the sheath, and sometimes, especially at its inferior part, unites at its external edge principally with that of its lower tendon.

Besides this anterior tendon, the transversalis muscle has a posterior.

This is attached by a straight edge to the posterior edge of the fleshy portion of the muscle, and divides into two layers, an *anterior* and a *posterior*.

The posterior layer is stronger; it is composed of transverse fibres, and is attached by separate slips to the summits of the transverse processes of the upper four lumbar vertebræ and to the lower edge of the twelfth rib. Near its insertion, the fibres converge from above and below, and unite in a point. This layer is situated between the common belly of the longissimus dorsi and quadratus lumborum muscles.

The anterior layer is much thinner, passes before the quadratus lumborum muscle, and is attached by its posterior edge to the roots of the transverse processes of the lumbar vertebræ.

The transversalis abdominis muscle corresponds to the triangularis sterni muscle in the direction of its fibres, in its situation, in the attachments of its external edge to the inner faces of the ribs, and by the insertion of its inner edge in the sternum and linea alba.

It acts like the preceding, but serves especially to contract the cavity of the abdomen in a transverse direction.

IV. LINEA ALBA.

§ 1066. The *linea alba* is a very firm tendinous band, which extends along the median line of the anterior wall of the abdomen. It is formed, by the union and crossing of the anterior tendons of the three broad abdominal muscles, within the sheath of the rectus abdominis muscle. Its greatest breadth, which is nearly half an inch, corresponds to the region of the umbilicus. From the umbilicus to the pubis, it narrows very rapidly; but it is there much thicker than at its upper part, where it is, on the contrary, much broader. Above, for nearly two thirds of the space between the umbilicus and xyphoid cartilage, it is from two to four lines broad; but below the umbilicus it is a line or two less.

In place of the umbilicus, in the early periods of life, we find an opening called the *umbilical ring* (*annulus umbilicalis*), through which the umbilical vessels and cord pass; but shortly after birth the opening closely unites with the remains of these same, so that here the linea alba has the most firmness.

The tendinous part of the anterior wall of the abdomen is here the firmest and strongest.

The linea alba is to the abdomen what the sternum is to the chest, except that it is not formed of bones. The anterior tendons of the broad muscles are attached to it, as the cartilages of the ribs articulate with the sternum; and the difference of tissue between it and the sternum depends on the general difference of structure between the thoracic and abdominal cavities, the former being almost wholly formed of bones, while the parietes of the latter are fleshy and tendinous.

Finally, we find in the crocodile a real abdominal sternum and abdominal ribs, a more perfect development of what is only indicated in man and most other animals.

§ 1067. The linea alba is sometimes deficient in a greater or less portion of its extent, from a primitive deformity, or at least from an imperfect development. It often happens that it is torn or accidentally distended.

These original deformities, and these consecutive alterations occasion an abnormal prolapsus of the abdominal viscera, which is called *umbilical hernia* (*hernia umbilicalis*) when it takes place through or near the umbilicus, and is most frequently the cause of *ventral hernia* (*hernia ventralis*) when it exists in any other place.

V. RECTUS ABDOMINIS.

§ 1068. The *rectus abdominis* muscle, *Sterno-pubien*, Ch., is situated on the inner part of the anterior face of the abdomen. It is very long, and narrow in proportion to its length, but still more thin than narrow. Its thickness gradually diminishes from below upward, while its breadth in this direction increases.

It is attached to the anterior edge and to the lower part of the anterior face of the cartilages of the fifth, sixth, and seventh ribs by three broad slips, of which the internal is the deepest and the external the highest. The two internal are the broadest, and are generally equal in breadth. The external is sometimes much thinner, simply tendinous, and adheres to the first slip of the obliquus externus abdominus muscle, or is replaced by it entirely ; so that the rectus abdominis muscle extends before it to the sixth rib.

The internal slip is attached also to the anterior face of the xyphoid cartilage and its ligaments.

Below, the rectus muscle terminates by a broad and short tendon, which is attached behind the pyramidalis muscle to the upper face of the horizontal branch of the pubis. Sometimes this tendon divides into two pillars, an external and an internal, the latter of which is broader ; although this division is not generally very perceptible.

The tendons of the two recti muscles are blended with each other at their lower part, even partly intercross, and descend from the symphysis pubis to the suspensory ligament of the penis.

The rectus abdominis muscle belongs to the class of poly-gastric muscles, and exhibits this arrangement more evidently than any other muscle. In fact it is always divided into several bellies by undulating tendinous intersections, formed of longitudinal fibres. Usually there are three of these intersections, and hence there are four bellies.

All these intersections have not exactly the same type. Their general characters are—

1st. They adhere intimately to the anterior layer of the sheath of this muscle. Generally speaking, they are more apparent forward

than backward, where they are sometimes invisible; sometimes they are seen in one part only. They adhere slightly and usually not at all to the posterior layer of the sheath.

2d. They are not generally found except above the umbilicus. The first is situated about as high as this region, the upper an inch below the upper extremity of the muscle, and the central about the centre of the space between the other two, although usually a little nearer the upper than the lower end.

Generally the lower two extend completely across the muscle, while the upper exists only in its inner part.

Sometimes however we find a fourth, which is imperfect, below the umbilicus. Sometimes also one of the superior is deficient, or is at least imperfect, as is always the case with the third.

These tendinous intersections are doubtless imperfect representations of the ribs in the parietes of the abdomen.

The rectus muscle is enclosed in a sheath formed by the three broad abdominal muscles, with which it is united by mucous tissue. Its fleshy portion is but feebly attached to it, but the tendinous intersections are very firm.

The posterior layer of this sheath is deficient at the upper part of this muscle, that which covers the costal cartilages to which it is attached, and at its lower part, from about the centre of the space between the umbilicus and the symphysis pubis. In these two parts the muscle rests directly on the anterior face of the costal cartilages above, and below on the anterior wall of the peritoneum, to which it unites by very loose cellular tissue.

The rectus abdominis muscle contracts the abdominal cavity in the direction of length, and assists to flex the vertebral column.

As it unites by its tendinous intersections with the external and internal oblique muscles, the effects of its contractions extend to these muscles, which in their turn affect the recti muscles. Consequently all these muscles act in concert.*

§ 1069. The rectus muscle sometimes presents a fourth slip, which arises from the external or internal part of its upper edge, more usually from the internal, and goes to the fourth rib. This formation resembles that of most mammalia, where it usually reaches to the second rib. It leads also by an insensible gradation to the formation of a special external abnormal sternal muscle.

This muscle divides in the direction of breadth more rarely than in that of length. We have however found on each side external to the proper rectus abdominis muscle, between the two obliqui muscles, a muscle which extended from the lower edge of the tenth rib to the centre of the external edge of the crest of the ilium†. This formation resembles that of birds, in which the rectus abdominis muscle is very broad.

* Bertin, *Mémoire sur l'usage des énervations des muscles droits du bas-ventre* in the *Mém de l'acad. de Paris*, 1746, p. 585.

† Kelch. *loc. cit.* p. 42.

The increase in number of the tendinous intersections of this muscle, and especially their existence below the umbilicus, are two circumstances important, as being analogous with the formation of the ape.*

VI. PYRAMIDALIS.

§ 1070. The *pyramidalis* muscle, *Pubio-sous-umbilical*, Ch., is situated at the lower part of the sheath formed by the tendons of the three broad abdominal muscles, and is covered forward by the anterior layer of this sheath, and backward by the lower part of the rectus muscle. It is triangular and oblong; its base is turned downward and its summit upward. It goes obliquely upward and inward, and arises from the internal portion of the horizontal branch of the pubis, between the insertion of the external pillar of the descending oblique muscle and the symphysis pubis, and its summit is attached to the lower part of the linea alba.

It strengthens the linea alba, and contracts the abdominal cavity from above downward.

§ 1071. The pyramidalis muscle is rarely abnormal. It is most usually deficient on one or both sides, and then the lower part of the rectus muscle is thicker and broader†. The absence of this muscle is a remarkable analogy with the formation of most animals.

More rarely it is multiplied on one‡ or on both sides§ thus presenting three or four muscles.

VII. DIAPHRAGM.

§ 1072. The *diaphragm* (*septum transversum*, *diaphragma*‖), a thin and broad muscle, is situated between the pectoral and abdominal cavities. It adheres by its upper face to the pleura and pericardium, and by its inferior face to the peritoneum. Its form resembles an inverted figure ∞, for it is broader from one side to the other than from before backward, contracts in the centre, and is circumscribed by rounded and convex edges. It arises from the upper lumbar vertebræ and is attached to the lower six ribs, and generally also to the unciform cartilage.

We may distinguish in it an *inferior* or *lumbar* portion (*pars lumbaris*), a *superior* or *costal* portion *pars costalis*), and a *median tendon* (*tendo intermedius*).

* Drelincourt in Blasius, *Anat. animal*, p. 110.—Vicq. d'Azyr, *Encyc. méth., Syst. anat. quadrup.*, vol. ii. p. 22.
† Santorini, *Obs. anat.* ch. ix. p. 160.
‡ Winslow, *Exp. anat.* p. 36.
§ Sabatier, *Tr. complet d'anat.*, vol. i. p. 263.
‖ Haller, *Nova icon. septi transversi*, Gottingen, 1741.—Santorini, *Tabulæ anat.* xvii. Parma, 1775, tab. x. fig.—Tissot, *Des fonctions du diaphragme*, Montpellier, 1823.

The lumber part is much thicker and smaller than the other, and arises on each side by four heads from the upper three lumbar vertebræ, and terminates in the posterior edge of the central tendon. The two halves of this portion represent an X ; in fact they unite in their centre, and again separate from each other above.

The four *heads* (*crura*), by which each portion of the lumbar part arises, follow from within outward and from below upward, so that they gradually shorten and go still farther outward and backward. Besides, the heads of the two sides are not perfectly similar ; those of the left are generally smaller than those of the right.

The first, the *internal* or most *inferior* right head, is stronger than the left, and arises below it, by a broad tendon, from its half of the anterior face of the third lumbar vertebra, somtimes also from the intervertebral ligament situated between the third and fourth. It is the largest of all.

The second strait head is situated behind the first, arises usually by a single tendon, sometimes by two, from the anterior face of the body of the second lumbar vertebra. Its muscular fibres are attached behind those of the first.

The third, which is sometimes larger and broader than the preceding, comes from the anterior face of the intervertebral ligament of the first and second lumbar vertebræ, and from the lateral part of the body of the first. It goes upward and outward.

The fourth arises from the transverse process of the second or first lumbar, or even of the last dorsal, vertebræ.

The heads of the left side generally arise half or even a whole vertebra higher than those of the right side.

Between the internal heads we find an oblong rounded transverse opening, tendinous at its lower part, which is the most extensive, and called the *hiatus aorticus*, through which the aorta descends, from the cavity of the thorax to that of the abdomen.

When the fleshy fasciculi of the several heads of the same side are united,* those of the right and left side are blended, and partly cross, before the upper extremity of the first lumbar vertebra.

A small part of the internal fasciculus of the left side usually passes before the right ; but a much larger portion of the right passes to the left, beneath this fasciculus, and forms the most internal portion of the left half of the lumbar part of the diaphragm.

This union is about an inch long. Above its upper extremity the lumbar portions of the muscle again separate, and form a longitudinal, rounded, and very oblong fissure, called the *hiatus* or *foramen* of the *œsophagus*. This opening is from an inch and a half to two inches long, and is a little on the left of the median line, and gives passage to the œsophagus. This opening is formed upward and inward by some of the fasciculi of the lumbar portions of the two sides, which incline towards each other and are blended together.

* The four heads on each side unite to form the *pillars* of the diaphragm.

The upper anterior edge of the two lumbar portions which proceeds on each side obliquely downward, outward, and backward, is attached to the posterior edge of the median tendon. The external is uninterruptedly continuous with the costal portion of the muscle.

The fibres of this part go from below upward. They separate like the sticks of a fan. The median tendon is triangular. Its form is similar to that of a trefoil leaf, and is broadest in the centre; its anterior edge is convex, and the posterior is concave. It extends from within outward, and from before backward, and its anterior and median portion is nearer the anterior edge of the muscle than the lateral parts are.

It is formed of tendinous fibres, which extend in different directions. The strongest and most numerous follow the direction of the fleshy fibres, that is, the internal and anterior go forward, those next more obliquely outward, the posterior backward, outward, and downward. But on the lower face of the tendon we also see others which cross them, and are very apparent on the sides, especially toward their posterior edge. The latter tend very much to strengthen the tendon.

We rarely find on a part of the inferior face of this tendon muscular fibres separate from the others.*

The right lateral portion of this tendon is perforated at its origin, near its central part, towards its posterior edge, and directly before the insertion of the lumbar portion; this opening is of an oblong square form, and is called the *foramen quadratum*, or the foramen of the *vena cava*, and the vena cava inferior passes through it. This foramen forms a short canal rather than a simple hole, for its lower edge is situated deeper than the upper. The posterior wall of this canal is considerably higher than the anterior, and is formed by the upper part of the right lumbar portion, which is covered with tendinous fibres. Around these edges considerable fibrous fasciculi are reflected, the anterior and posterior of which go obliquely inward, forward, and upward, while the internal and external go downward.

From the anterior edge, and the external part of the posterior edge of this median tendon, the costal portion of the diaphragm arises by a very concave edge, and goes outward and backward, where it terminates by a convex edge.

The two halves of this portion are blended with each other forward and on the median line, but they are separated backward by the lumbar portion.

The anterior fibres are the shortest and the central fibres the longest. The anterior go directly forward; the next in succession become more oblique, and finally go transversely outward; the posterior go from before backward, and from within outward.

The external edge of this part is always attached by rounded slips, which are separated more or less distinctly and are sometimes cleft, to the internal face of the cartilages of the seventh, eighth, ninth, tenth,

* Huber, in *Sœmmerring, Muskellehre*, p. 162.

and eleventh ribs, and also to the inner face of all the twelfth, and usually blends with the posterior edge of the transversalis abdominis muscle, which goes forward to meet it.

The central part of the anterior edge is also most generally fixed to the posterior face, and to the lower extremity of the xyphoid cartilage, by two thin slips, which go downward and outward.

Sometimes however these slips do not exist. Their absence must be considered as a slight indication of the imperfect union of the right and left halves of the body.

When the diaphragm contracts it acts on the thoracic and abdominal cavities; but its action on them is opposite. In contracting, it rises and falls; its fleshy portion, which is attached backward to the lumbar vertebræ, and forward to the ribs, draws the central tendon downward. Hence the pectoral cavity is considerably enlarged from above downward, while the abdominal cavity is proportionally diminished in the same direction. The former places the diaphragm among the agents of inspiration; in fact, when the respiration is calm and tranquil, its contraction and relaxation produce the alternate motions of inspiration and expiration. Again, it constantly contributes, by the changes it causes in the cavity of the abdomen, to the progress and in general the motion of the substances in the alimentary canal, and consequently it assists directly in digestion. In this last relation it is an auxiliary to the other broad and straight muscles of the abdomen, while it is an antagonist to them in relation to the cavity of the thorax. Simultaneous and powerful contractions of the diaphragm and of the other abdominal muscles, produce *efforts* (*nixus*)* which contract the abdominal cavity as much as possible, in order to expel the foreign matters actually within, or which we believe to be within it, and the expulsion of which is unusually difficult. This combined action consequently takes place in all cases where fœcal matter or urine is retained from any cause whatever, as dysentery, inflammation of the neck of the bladder, parturition, &c.

§ 1073. The diaphragm is sometimes wholly or partially deficient from a primitive deviation of formation, or it may be torn by some mechanical cause acting with violence on it. In both cases, as also when the muscle is ruptured, a part of the viscera usually passes into the chest through the abdominal opening; hence results a *diaphragmatic hernia* (*hernia diaphragmatica*), which generally has no herniary

* Bourdon (*Recherches sur le mécanisme de la respiration et sur la circulation*, Paris, 1820,) has determined by some interesting inquiries that the functions of the diaphragm are confined to inspiration and analogous acts, and that it affects digestion and the abdominal secretions; but that in respect to these acts, it only prepares for them by filling the lungs with air, and that it does not take an active part in this phenomenon, since the suspension of respiration, which is the principal source of them, and which depends upon the closing of the glottis, prevents, not during respiration, but during the tendency to expiration, which is produced solely by the contraction of the abdominal muscles. F. T.

ARTICLE SECOND.

OF THE MUSCLES OF THE CHEST.

§ 1074. In the pectoral region of the anterior and lateral faces of the body we count three superficial muscles, which go from the first two sections of the upper extremities to the accessory bones of the trunk, and are usually attached to the latter. These muscles are the pectoralis major, the pectoralis minor, and the serratus major anticus muscles.

I. PECTORALIS MAJOR.

§ 1075. The *pectoralis major* muscle, *Sterno-humeral*, Ch., an extensive muscle, the largest and most superficial of those found on the anterior part of the chest, is triangular, or, to speak more precisely, is irregularly quadrilateral, and is much thicker but much narrower at its outer than its inner part. Its smaller upper edge arises by short tendinous fibres from the great inner half of the anterior edge of the clavicle. The inner edge, which is larger and concave, also arises by very short tendinous fibres, from the anterior face of the handle of the sternum, from that of almost all the upper part of the body of this bone, and also from the upper edge of the anterior face of the cartilage of the fifth rib. A smaller slip is also detached from the rest of the muscle in all its extent, which sometimes descends very low, and unites to the second slip of the obliquus externus abdominis muscle, as the lower outer part of this edge blends with the upper edge of the tendon of this muscle and of its upper slip.

The upper part of the pectoralis major muscle is called the *clavicular* portion (*pars clavicularis*), the central part the *sternal* portion (*pars sternalis*), and the lower the *costal* portion (*pars costalis*). The last however is not separated from the others as the first is.

The upper fibres of this muscle descend obliquely outward, the central are transverse, and the lower go more and more obliquely upward. They all converge towards a very strong tendon, composed of transverse fibres, which, passing above that of the long head of the biceps flexor muscle, goes to attach itself to the lower part of the outer rough line of the humerus, and blends in the bicipital groove with the tendon of the latissimus dorsi and teres major muscles, unites in this place with the lower part of the deltoid muscle, and becomes an aponeurosis, which envelops the muscles of the shoulder.

This muscle draws the arm, and also all the upper extremity, inward and forward, which at the same time is turned on its axis inward and depressed if it be raised. Its central and transverse portion goes directly inward and forward; the upper portion raises the arm, the lower depresses it.

§ 1076. The clavicular portion of this muscle is very often entirely separated from the sternal portion, so that a considerable space exists between them, and on the anterior edge of the latter we see several fissures of different depths. This formation is very analogous with that of the mammalia, in most of which the pectoralis major muscle is divided into several distinct muscles.

A considerable muscular band is sometimes detached from the pectoralis major muscle, which goes to the arm, where it is attached either to the aponeurosis, or to the short head of the biceps flexor, or finally to the latissimus dorsi muscle, which arrangement resembles the common muscle of the arm, shoulder, and head, found in animals destitute of a clavicle.

§ 1077. On the anterior face of the pectoralis major muscle, more or less distant from its inner edge, directly between it and the cellular coat, we often find a supernumerary muscle, called from its situation the *thoracic*, the *straight sternal*, or the *sternal* muscle of animals [*M. thoracicus, rectus sternalis, sternalis brutorum*).

This muscle is a more or less perfect repetition of the rectus abdominis and of the sterno-cleido-mastoideus. It often unites these two muscles, or at least extends from one to the other; sometimes also it is unconnected with either, and is attached by its upper extremity to the handle of the sternum, and by the lower to the costal cartilage or to the lower part of the sternum: its two extremities are often blended with the pectoralis major muscle. In certain cases it is indicated only by a tendon, which extends from the sterno-cleido-mastoideus to the rectus abdominis muscle, or by an unusually long slip of the latter.

The accessory muscle varies in thickness, breadth, and even in number, no less than in its length. In fact its thickness is sometimes only a few lines and is sometimes several inches; sometimes it exists only on one side, sometimes also it is double either on one or on both sides; sometimes we number four of these muscles.

In certain subjects there are transverse tendinous intersections, which render it still more analogous to the rectus muscle: these intersections are not common.

The side of the body and the sex of the individual seem not to influence the existence of this muscle.*

It is curious inasmuch as it establishes a relation between man and animals, renders the analogy between the anterior and posterior halves of the body more sensible than it is generally, and particularly renders the whole anterior face more uniform.

It is not peculiar in blacks.

* For farther details on this interesting muscle, see Sandifort, *De musc. non-nisi quibusdam rarius occurrunt*, in the *Exerc. acad.* Book i. ch. vi. pp. 82-88.—Meckel, *monstr. duplicitate*, Halle, 1815, pp. 35-40.—Kelch., *Beytraege*, p. 33, No. 25.

II. PECTORALIS MINOR.

§ 1078. Directly below the pectoralis major we find the *pectoralis minor* muscle, *Costo-coracoidien*, Ch., (*M. pectoralis minor*, s. *serratus anticus minor*), which is much smaller. The form of this muscle is an elongated triangle, the base of which looks downward and forward, and the summit is turned upward and backward.

Its anterior edge is generally attached by three, more rarely by two or four slips, all of which proceed equally far forward, but at unequal distances from each other, to the anterior face and upper edge of the third, fourth, and fifth, rarely also the sixth rib.

A fourth slip is sometimes found behind the second, and more or less covered by it, and also by the third, which is inserted in the outer face of the fourth rib.

The upper and the posterior or lower edge, which are much longer than the anterior, and which are nearly equal in length, are loose and unite above in a tendon, which is attached to the anterior edge of the summit of the coracoid process of the scapula.

The pectoralis minor muscle is much narrower, but also much thicker, at its upper than at its lower part.

It draws the coracoid process, and consequently the scapula forward, downward, and inward. When the scapula is fixed, this muscle raises the ribs to which it is attached.

§ 1079. Sometimes we find a curious analogy with the formation of birds in the existence of a third pectoral muscle below these: this arises from the first and second ribs by separate digitations, and is attached to the coracoid process of the scapula.* A similar anomaly consists in a band, which sometimes comes from the upper rib, and which, covered by the pectoralis minor muscle, ascends to the capsular ligament of the scapulo-humeral articulation.†

III. SERRATUS MAJOR ANTICUS.

§ 1080. The *serratus major anticus* muscle, *Costo-scapulaire*, Ch., is a broad, thin, and triangular muscle, the base of which is downward and the summit upward. It covers in great part the lateral region of the upper eight ribs.

Its anterior concave edge arises by nine triangular slips, of which the lower four are situated farther forward than the others, from the bony parts of the first eight ribs, nearer their anterior than their posterior extremity.

The number of slips then exceeds that of the ribs, because the second and third, one of which is often deficient, are attached together to the second rib. The four lower slips intercross with the upper four

* Rosenmüller, p. 6. † Gantzer, p. 11.

of the obliquus externus abdominis muscle. The lower edge is loose. The posterior is attached to all the internal lip of the inner edge of the scapula.

The upper fibres descend obliquely forward and inward: the central are transverse; the lower fibres have the same direction as the upper, but are less perpendicular than they.

This muscle generally draws the scapula, and with it all the upper extremity forward and inward. When this bone is fixed it carries the ribs to which it is attached outward and backward.

§ 1081. Sometimes but very rarely, the central portion of the serratus major muscle is deficient, so that it is completely divided into two unconnected parts.

IV. TRIANGULARIS STERNI.

§ 1082. The *triangularis sterni* muscle, *Sterno-costal*, Ch., is thin; it is situated upon the inner face of the sternum and costal cartilages, and is formed of several successive slips placed over each other. It arises by a thin and broad tendon from the edge of the under part of the body of the sternum, from the ensiform cartilage, and from the inner face of the costal cartilages from the third to the sixth or seventh. Its fibres are oblique and go to the cartilages of the second, third, fourth, and fifth ribs, to which they are attached by long digitations.

Of all the muscles this is one of the most variable. Sometimes one or more slips are deficient, and the internal edge is not attached to the costal cartilages but only to the inner face of the sternum; and again several slips are formed which are entirely isolated, or at least some of them are not connected with the others.

It is always continuous at its lower extremity by tendinous fibres, and often by its fleshy portion with the upper end of the transversalis abdominis muscle; so that in many cases, but not however in all, we may consider it as forming but one with it, and call it the *sterno-abdominal* muscle (*M. sterno-abdominalis*).*

It at least always represents in the thorax the transversalis abdominis muscle. This comparison terminates the analogy between the muscles of the abdominal and thoracic parietes.

ARTICLE THIRD.

OF THE ANTERIOR MUSCLES OF THE NECK.

§ 1083. The anterior muscles of the neck form a superficial and a deep layer.

* Rosenmuller, *De nonnullis musculorum corp. hum. varietatibus*, Leipsic, 1814.

I. SUPERFICIAL LAYER.

§ 1084. The superficial layer of the anterior muscles of the neck is situated in front and on the sides of the larynx, the trachea, the pharynx, and the hyoid bones. It comprises the platysma myoides, the sterno-cleido-mastoideus, the sterno-hyoideus, the omo-hyoideus, the sterno-thyroideus, and the muscles which extend from the larynx to the hyoid bones, from the thyroid to the cricoid cartilages, and from the skull to the hyoid bones and to the pharynx. We shall mention in this place only the first two. The others will be described with the organs of digestion and of voice,—1st, because their points of attachment have not yet been described; 2nd, because it is more convenient to refer the history of those which are inserted in parts already described, as for instance the muscle of the hyoid bones, to that of the muscles near them, which are intimately connected and always act with them.

I. PLATYSMA MYOIDES.

§ 1085. The *platysma myoides* muscle, *Thoraco facial*, Ch., (*M. latissimus colli*, s. *platysma myoides*, s. *quadratus*, s. *tetragonus genæ*), has an oblong square form. It is very thin and composed of muscular bands, which are generally very loosely united and often have considerable spaces between them. It is situated directly below the cellular tissue, to which it adheres, and arises in the thoracic and scapular region by separate bands, which extend a little below the clavicle, so that it covers part of the upper edge of the deltoides and pectoralis major muscles. It gradually contracts, becomes thicker and going obliquely upward, inward, and forward, on the side of the neck, attains the lower part of the face, where it is attached partly to the under edge of the lower maxillary bone, and partly blends with the levator anguli oris muscle and ascends to the corner of the mouth, and partly loses itself below the adipose covering of the face.

It wrinkles the skin which covers it, and draws the mouth downward and outward. The latter motion is executed particularly by the last fasciculus, hence called the *risorius Santorini* muscle.

This muscle is evidently only a rudiment of the intercostales and of the broad abdominal muscles in the neck, as is proved by its situation, its relations with the other muscles and the common integuments, and by the direction of its fibres. The looseness of its lower edge, which is wholly unattached, corresponds very well with the arrangement of the anterior part of the lower edge of the broad abdominal muscles, as likewise its insertion in the lower maxillary bone resembles that of the upper edge of these muscles in the ribs, to which the lower maxillary bone is analogous.

Its less degree of development depends partly on the smallness of the region in which it is found, and partly also because there is no special cavity in it.

§ 1086. A special fasciculus frequently, but not always, arises from its upper part and goes toward the face. This fasciculus is sometimes loose under the cellular tunic and sometimes arises from the tendon of the masseter muscle. It goes from behind forward, and is attached with the platysma to the angle of the lip; it is sometimes replaced by the upper part of the latter, which is broader.

It is more rare to find an inferior slip arising from the clavicle, which extends under the skin to near the deltoid muscle, where it disappears in the cellular tissue; it resembles the fleshy coat of animals.*

We also rarely find a small transverse muscular slip between the platysma and the skin, below the chin.†

We more rarely see the platysma not thin and superficial as usual, but rounded and thick, not proceeding forward but going backward and attached to the occipital bone.‡

II. STERNO-CLEIDO-MASTOIDEUS.

§ 1087. The *sterno-cleido-mastoideus* muscle, *Sterno-mastoidien*, Ch., must be regarded not as a single muscle but as the union of two muscles, since its two bellies are more distinct from each other than some other muscles, especially those of the dorsal region, which are considered as separate.

The anterior belly, the *sterno-mastoideus* muscle (*M. sterno-mastoideus*, s. *nutator capitis anterior*), arises by a short but strong tendon from the most upper and outer part of the anterior face of the handle of the sternum. It is elongated and rounded, and becomes insensibly broader and thinner at its summit, goes obliquely upward and backward, and is attached to the outer face of the mastoid process of the temporal bone, and to a small part of the outer face of the upper curved line of the occipital bone.

The posterior belly, the *cleido-mastoideus* muscle (*M. cleido-mastoideus*, s. *nutator capitis posterior*), is shorter and weaker than the preceding. It arises an inch more outwardly, from the upper edge and the upper part of the anterior face of the sternal part of the clavicle (but it does not come from its inner edge) by a thin and broad tendon; it descends obliquely but straighter than the preceding, gradually becomes round, and terminates in a point, where it is attached below the preceding, to the lower part of the outer face of the mastoid portion of the temporal bone by a rounded tendon, which covers its upper portion, and with which it is united by some separate fibres.

* Gantzer, *loc. cit.*, p. 111.
† Fleischmann, in *Erlanger Abhandl.*, vol. i. p. 28.—Gantzer, *loc. cit.*, p. 6.
‡ Zagorsky, *Mém. de l'acad. de Petersburgh*, vol. i. p. 357.

These two muscles correspond from above downward, the first to the rectus abdominis and the second to the pyramidalis muscle, in this respect, that they are more similar than the latter in regard to size. They represent also from before backward the splenii muscles, to which they are antagonists.

The sterno-cleido-mastoideus muscle inclines the head obliquely forward, so as to bring the face from the opposite side. When the two act in concert the head is flexed. The external belly draws it more directly forward and downward, and the inner belly more obliquely from the opposite side.

§ 1088. The greatest anomaly of this muscle is an increase in number, arising from the detachment of some fasciculi from the rest of the mass.*

Thus for instance we not unfrequently find between the two bellies a special and smaller fasciculus, which sometimes continues separated as far as its upper extremity, or which before arriving there blends with one of the other two; this generally arises directly at the side of the anterior belly, either on the outside of it from the sternum or from the most internal part of the sternal end of the clavicle.

We less frequently find a thinner and usually very broad accessory muscle, which arises from the clavicle behind the second belly, ascends behind it from before backward, and attaches itself on the outer side of it to the occipital bone.

The numerous divisions and multiplications of this muscle remind us of the analogy between it and the rectus abdominis and pyramidalis muscles.

Nor is it rare to see a fleshy or tendinous slip which extends from the lower edge of the sterno-mastoid portion to the angle of the lower maxillary bone.†

All these varieties form so many analogies with animals; for in most mammalia the sterno-mastoid and the cleido-mastoid portions are almost entirely separated from each other, and the latter is most frequently doubled. Besides, this always increases in volume and number outwardly; this circumstance establishes a manifest relation with the formation in most mammalia, in which the cleido-mastoideus muscle is generally blended with the clavicular portion of the deltoides muscle; even in the solipedes, the sternal portion extends only to the lower maxillary bone.

II. DEEP LAYER.

§ 1089. The deep layer of the anterior muscles of the neck is situated directly on the anterior face of the upper part of the vertebral column. It comprises the *rectus capitis anticus major*, the *rectus capitis*

* G. Meckel, *De duplicitate monstrosâ*, pp. 40, 41.—Kelch, *Beytraege zur path. anat.*, p. 31.

† Brugnone, p. 160.

minor, and the *longus colli* muscles, all of which serve to bend the head and neck.

I. RECTUS CAPITIS ANTICUS MAJOR.

§ 1090. The *rectus capitis anticus major* muscle, *Grand trachelo-sous occipital*, Ch. (*M. rectus capitis anterior*, s. *internus*, s. *major*), is oblong and thicker at its upper than at its lower part. It generally arises by five thin and tendinous slips, which increase in size from below upward, from the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, and from one slip of the longus colli muscle, which is attached to the sixth cervicle vertebra. It goes from below upward and from without inward, gradually approaching its congenital. It is mostly strongly tendinous. Its upper edge is attached directly before the large occipital foramen to the basilar process of the occipital bone.

It bends the head directly forward.

§ 1091. We sometimes find two additional upper tendinous slips which come from the first and second cervical vertebræ, an arrangement resembling the formation of the carnivorous animals.

II. RECTUS CAPITIS ANTICUS MINOR.

§ 1092. The *rectus capitis anticus minor* muscle, *Petit trachelo-sous occipital*, Ch. (*M. rectus capitis anterior*, s. *internus*, s. *minor*), is a smaller, thinner, and triangular muscle, which gradually enlarges from below upward. It arises above and forward from the anterior arch and from the root of the transverse process of the first cervical vertebra, ascends, covered by the preceding, before the articular ligament between the occipital bone and the first cervical vertebra, goes obliquely inward, and is attached before the occipital foramen to the basilar process, and more outwardly to the fibro-cartilaginous mass which fills the space between the body of the occipital bone and the petrous portion of the temporal bone.

It bends the head forward and a little to the side.

III. LONGUS COLLI.

§ 1093. The *Longus colli* muscle, *Predorso-atloidien* Ch., descends from the first cervical to the third or fourth dorsal vertebra. Its structure is very complicated, and we may consider it to a certain extent as formed of two muscles, an upper and lower, which are united.

The internal is smaller, and goes directly downward and a little outward. It arises by separate tendinous slips from the side of the body, and the intervertebral cartilages of the upper three dorsal vertebræ, and also from the body and the anterior roots of the transverse processes of the lower four cervical vertebræ, ascends in a straight line,

and is attached externally, by two or three short tendons, to the anterior tubercle of the transverse processes of the fourth and fifth cervical vertebræ; and inward, by a strong tendon, to the anterior face of the bodies of the second and third cervical vertebræ.

The upper muscle is stronger than the preceding, and is directly continuous with it; it arises by small tendinous slips from the anterior roots of the transverse processes of the third, fourth, and fifth cervical vertebræ. It ascends obliquely inward, gradually becomes straighter, and is attached to the anterior tubercle of the first cervical vertebræ, seldom to the basilar portion of the occipital bone.

The longus colli muscle bends the neck forward, and a little to the side.

ARTICLE FOURTH.

OF THE SACRO-COCCYGŒAL MUSCLES.

§ 1094. the *sacro-coccygœal* muscles (*M. sacro-coccygœi*, s. *curvatores coccygis*) are not constant. When they exist they appear as small, elongated, thin, and mostly tendinous fasciculi, situated on the two sides, which arise from the anterior face of the last sacral and first coccygœal vertebra, and are attached by several slips to the anterior face of the lower pieces of the coccyx, where that of the right and left are usually blended.

They draw the lower pieces of the coccyx forward and upward, so as to curve the whole range of these bones.

These muscles are the rudiments of the caudal flexors in animals. They evidently correspond to the three muscles of the upper half of the body, which we have just described.

SECTION II.

OF THE MUSCLES OF THE HEAD.

§ 1095. The muscles of the head comprise those of the skull and those of the face.

The muscles of the skull are the occipito-frontalis, the auricular muscles and one muscle of the lower jaw.

The muscles of the face are those of the eyes, the nose, the lips, the other muscles of the lower jaw, and the hyoid muscles.

Of these muscles we shall here examine only the occipito-frontalis, and those of the lower jaw, both because the parts which must necessarily be known to understand the descriptions of the others are not yet mentioned, and also because it is more convenient to examine them

in connection with the other constituent parts of the organs which they assist to form.

I. OCCIPITO-FRONTALIS.

§ 1096. The *occipito-frontalis* or *epicranial* muscle (*M. epicranius*, s. *cranii cutaneus*, s. *occipito-frontalis*) is a flat, digastric muscle, situated directly under the skin, to which it is intimately attached, and covers the anterior, upper, and posterior parts of the skull, and also the central and upper part of the face.

Its posterior belly, which is also described as a separate muscle, termed the *occipitalis*, has an oblong square, or triangular form. It arises by tendinous fibres from the root of the mastoid process, and from the upper occipital ridge of the basilar bone, where it unites with the sterno-cleido-mastoideus and trapezius muscles, soon becomes fleshy, ascends on the squamous portion of the occipital bone, and terminates by a concave edge which unites with the median tendon.

This tendon is called the *skull-cap* (*galea capitis*), and is formed of very distinct longitudinal fibres. It extends all along the skull to the frontal bone, where it is attached to the anterior belly or the frontalis muscle.

The anterior belly or the *frontalis* muscle is much more extensive than the posterior. It begins by an upper convex edge, then descends along the squamous portion of the temporal bone, goes straight to its inner part, which is the thickest, and obliquely forward to the outer, which is thinner, and terminates as follows: at its inner part, it is continuous by several slightly tendinous slips with the pyramidalis nasi and the levator labii superioris alæque nasi muscles; in the region of the inner angle of the eye, it is attached to the nasal process of the upper maxillary bone and to the lower portion of the frontal bone; finally, at its outer part, it blends with the corrugator supercilii and the orbicularis palpebrarum muscles.

The occipito-frontalis musclee orresponds in situation and attachment to the interspinales muscles of the vertebræ. It resembles one of these muscles which is enlarged, rounded, and divided in its centre, from before backward, into two parts, united by an intermediate tendon.

Considered as a whole, this muscle moves the skin of the top of the head. Its two bellies wrinkle in a transverse direction the skin above them, and extends that near them when they contract from the side of their tendon. Thus the frontal muscle raises that of the upper part of the neck.

II. MUSCLES OF THE LOWER MAXILLARY BONE.

§ 1097. The muscles of the lower maxillary bone comprise those which raise it, those which move it to the side, and those which depress it.

I. LEVATORS OF THE LOWER JAW.

§ 1098. The lower jaw is moved by three levators, the action of which is to bring it towards the upper jaw, which is fixed. These are the temporalis, the masseter, and the pterygoideus internus muscles.

A. TEMPORALIS.

§ 1099. The *temporalis* muscle, *Temporo-maxillaire*, Ch., the largest and strongest of all the muscles of the lower jaw, is broad and triangular. It occupies all the lower region of the central part of the lateral face of the skull, for it fills the temporal fossa, and covers the plain semicircular surface.

It arises by very short tendinous fibres and by a convex edge from the semicircular line which bounds the lower part of the outer face of the frontal bone, from the large wing of the sphenoid bone, from the parietal bone, and the squamous portion of the temporal bone, and by fleshy fibres from the parts of these same bones situated below this line. Its posterior fibres go from above downward and from behind forward, the central are almost perpendicular, the upper go from above downward and from before backward; all converge to unite in the temporal fossa.

As they leave the circumference the muscle becomes narrower and thicker, and terminates in a short but very strong tendon, which is attached to the coronoid process of the lower maxillary bone.

The entire muscle is covered externally by a tendinous expansion, formed of descending fibres which arise immediately over it, serves for the attachment of its fibres above, is separated below, on its outer face, by a greater or less quantity of fat, and is very loosely united to it in this place by cellular tissue and vessels, and is attached to the posterior edge of the malar bone and also to the upper edge of the zygomatic arch.

This muscle draws the lower jaw forward and upward.

B. MASSETER.

§ 1100. The *masseter* muscle, *Zygomato-maxillaire*, Ch. (*M. masseter*, s. *mandibularis externus*), has an oblong square form. Its length exceeds its breadth, and it is formed of fibres which go upward. It covers the outer face of the ascending branch of the lower maxillary bone, and fills the space between the posterior part of the lower edge of this bone and the zygomatic arch.

It is very evidently formed of two layers entirely separate from each other, which differ also in the direction of their fibres, and which may be regarded as two distinct muscles.

The anterior external layer is the longest and strongest, and covers most of the lower. It is formed of fibres which are oblique from above

downward and from before backward, and become a little narrower from below upward. It arises by short tendinous fibres from the lower edge of the malar bone, and is attached to the lower half of the ascending branch of the lower maxillary bone, as far as its inferior edge and its angle.

The inferior or posterior layer is much smaller and feebler than the preceding; its form is also square, and it is composed of fibres which go backward. It becomes thicker from below upward, is loose posteriorly, and is covered anteriorly by the preceding layer. It arises by fleshy fibres from the lower edge of the posterior part of the zygomatic arch, and is attached by short tendinous fibres above the upper end of the insertion of the external layer in the centre of the outer face of the ascending branch of the lower maxillary bone.

The two layers unite and draw the lower jaw upward, the external brings it forward, and the internal backward.

C. PTERYGOIDEUS INTERNUS.

§ 1101. The *pterygoideus internus* muscle, *Grand ptérygo-maxillaire*, Ch., an oblong quadrangular muscle, arises by its upper thick edge from all the pterygoid fossa of the pterygoid process of the sphenoid bone, goes obliquely downward and outward, and is attached, opposite the preceding, but to a much less extent than it, to the lower part of the inner face of the ascending branch of the lower maxillary bone, as far as the angle.

It draws the jaw upward and inward; but if the muscles of both sides act, the jaw is moved directly upward.

II. PTERYGOIDEUS EXTERNUS.

§ 1102. The lower jaw is moved laterally by a single muscle, the *pterygoideus externus* muscle, *Petit ptérygo-maxillaire*, Ch., situated between the lower maxillary bone and the pterygoid process. This is the smallest muscle of the lower jaw, and differs from the others in the transverse direction of its fibres. It arises by short tendinous fibres from all the outer face of the outer layer of the middle sphenoid or pterygoid process, then goes directly backward and outward, and is inserted by short tendinous fibres in the inner face of the neck, and of the condyle of the lower maxillary bone.

It draws the lower jaw from the opposite side, that is inward and forward, when it acts alone; but forward only when it contracts with its synonymous muscle of the other side.

III. DIGASTRICUS.

§ 1103. Although several muscles contribute more or less directly to depress the lower jaw,* there is however but one appropriated specially to this function; this is the *digastricus* muscle, *Mastoido-genien*, Ch., (*M. biventer, maxillæ inferioris*), so named because formed of two oblong bellies united by a central tendon.

The posterior longer and stronger belly is more rounded than the other, aud arises from the mastoid fissure of the temporal bone, and is covered in this part by the upper end of the sterno-cleido-mastoideus muscle. Leaving this point, it goes downward, forward, and inward, and gradually becomes a thinner oblong median tendon, which is attached by a small tendinous expansion on its anterior extremity to the lateral end of the central piece of the hyoid bone; so that it is situated between the temporal and hyoid bones.

The anterior belly is shorter and flatter than the posterior, and arises behind the median tendon; goes forward and inward, and is attached directly at the side of the synonymous belly of the opposite side to the centre of the inner lip of the lower edge of the jaw.

This muscle draws the lower jaw downward and backward. If the posterior acts alone, it raises the hyoid bone and draws it backward. If the anterior acts singly, this bone is also raised but carried forward. When the posterior belly contracts behind and the anterior before, it draws the skull and the face, except the lower jaw, backward, and thus by its action on the skull raises the upper jaw, separates it from the lower, and opens the mouth.

§ 1104. A very common anomaly of this muscle consists in the union of the anterior bellies of the two sides with each other and with the pterygoideus externus muscle, by the formation of a larger or smaller fleshy portion.† Sometimes too we find between it and the skin a special transvere fasciculus, which is extended between the branches of the lower maxillary bone.‡

These anomalies are evidently imitations of what is seen in several mammalia, where the anterior bellies even blend with each other.

More rarely the anterior belly does not extend to the chin, but is attached to the centre of the horizontal branch of the lower maxillary bone, as is also the case in many mammalia, where the single muscle with which it is provided is also inserted more posteriorly than in man.

* A. Monro, *Remarks on the articulation, muscles, and luxation of the lower jaw*, in the *Edinburgh medical Essays*, vol. i. p. 103-129.—J. C. Platner, *De musculo digastrico maxillæ inferioris*, Leipsic. 1737.—Winslow, *Observ. sur l'anatomie comparée sur l'usage des muscles digastriques de la machoire inférieure dans l'homme*, in the *Mém. de Paris*, anno 1742, p. 236.

† G. Meckel, *De duplic. monstr.*, p. 42.

‡ Fleischmann, in the *Erlanger Abhandl.*, vol. i.

SECTION II.

OF THE MUSCLES OF THE EXTREMITIES.

§ 1105. The muscles of the extremities form the greater part of these sections of the body. Most of them have a more or less elongated form and assume a longitudinal direction, although this is not the direction of their fibres, which go obliquely from one or more edges to the tendons. Very few of them have a transverse direction, or one intermediate between it and the preceding: the latter are shorter.

The muscles which follow the longitudinal direction flex and extend the different parts of the limbs; the transverse and the oblique separate them from each other or turn them on their axes.

The muscles of both extremities are surrounded with general *tendinous sheaths* (*fasciæ aponeuroticæ*) and the tendons of the inferior, which are the longest in proportion, and are firmly attached in several places by strong fibrous ligaments to the bones over which they pass.

In regard to situation, arrangement, and number, they correspond perfectly in their essential particulars, and differ only in modifications dependent on the different functions of the two limbs.

CHAPTER I.

MUSCLES OF THE UPPER EXTREMITIES.

§ 1106. The muscles which move the first section of the bones of the upper extremity, or the bones of the shoulder, all come from the bones of the trunk, from which arise also some of those which move the bone of the second section—the humerus. The former are the trapezius, the rhomboidei, and the levator anguli scapulæ; the others the pectoralis major and the latissimus dorsi muscles, which have already been described (§ 1001).

It is convenient to commence the description of these muscles by that of their common aponeurotic sheath.

ARTICLE FIRST.

OF THE APONEUROTIC SHEATH OF THE UPPER LIMBS.

§ 1107. The muscles of the upper extremities are surrounded by a tendinous envelop, called the *brachial aponeurosis* (*fascia brachialis*).

This arises in very muscular subjects from the deltoid muscle, but sometimes we do not see it except below this muscle. It is always stronger on the fore-arm than on the arm. However, at the posterior part of the anterior and posterior faces it is always much thicker than on the other faces and strengthened by transverse and oblique fibres, which cover the longitudinal fibres externally.

In most of its extent it envelops the muscles externally only. However, at the lower end of the arm, in the inner angle, there is a triangular slip, the *internal* and *external intermuscular* ligament, (*L. intermusculare internum et externum*), which leaves the aponeurosis and goes forward. The external extends from the outer condyle to the upper extremity of the projecting part of the anterior angle; the internal from the inner condyle to the corresponding point of the inner angle. They extend between the extensors and flexors of the fore-arm and increase their surfaces of attachment.

Two similar but much weaker ligaments are also found in the fore-arm in a similar situation. They separate the flexors and the extensors, both on the ulnar and radial side; because they proceed from the inner face of the aponeurosis to the posterior edge of the ulna and of the radius to which they are attached.

Near the lower end of the fore-arm, the transverse fibres disappear, or at least become evidently thinner; but they again accumulate on the end of its posterior face and on the back of the thumb, become much more thick than high, and give rise in this place to the *dorsal ligament of the carpus* (*Lig. carpi dorsale*, s. *armillare*).

This ligament extends from the transverse process of the radius to the small head of the ulna, the pisiform, and the tuberosity of the fifth metacarpal bones. It is formed at its upper part, which is the weakest, of transverse fibres, which descend from the ulna to the radius, and at the lower part of fibres, which go backward and downward from the radius, and consequently partially cross the preceding.

Under it pass the tendons of the abductor magnus and extensor pollicis, the radiales externi, the extensor digitorum communis, the extensor indicis proprius, the extensor minimi digiti proprius, and the ulnaris externus muscles. Their passage is facilitated by the partitions which descend from the inner face of the ligament to the asperities on the ends of the bones of the fore-arm and divide it into six parts.

The first, the anterior, extends from the anterior edge of the lower end of the radius to the first asperity on the back of this bone, and contains the tendons of the abductor pollicis longus and of the extensor pollicis brevis muscles.

Through the second, which is larger and which extends from the first dorsal asperity to the second, pass the tendons of the two radiales externi muscles.

The third, a little oblique forward and downward, extends from the second to the third dorsal asperity of the radius, to the posterior edge

of its lower extremity, and lodges the tendon of the extensor pollicis longus muscle.

The fourth, the largest, extends from the third dorsal eminence to the posterior edge of the radius, and receives the tendons of the extensor digitorum communis and extensor proprius indicis muscles.

The fifth, the smallest, is comprised between the radius and the anterior edge of the small head of the ulna ; it receives the tendon of the extensor minimi digiti proprius muscle.

Finally, the sixth, which extends from the posterior edge of the small head of the ulna to its styloid process, embraces the tendon of the ulnaris externus muscle.

The lower edge of this ligament, which should be regarded not as a separate ligament but only as the development of the brachial aponeurosis, is uninterruptedly continuous with the aponeurosis of the back of the hand, which gives a loose common envelop to the tendons of the extensor muscles, blends with the oblique tendinous fibres by which the tendons of the extensors of the fingers are retained in place, and concurs to form them.

The brachial fascia is also strengthened at the lower part of the anterior face of the fore-arm and on the palmar side of the carpus.

The upper part of this portion, which is the feeblest and which extends from the anterior ridge of the radius to the pisiform bone, forms the *common palmar ligament of the carpus* (*Lig. carpi volare commune*). It unites at its ends with the dorsal ligament. Under it pass the tendons of the flexors of the fingers, and in a special sheath that of the radialis internus.

The lower part, which is much stronger, forms the *proper palmar ligament of the carpus* (*Lig. carpi volare proprium*). This ligament is formed by transverse and oblique fibres. Above, it blends in great part with the preceding. Below, it strengthens the palmar aponeurosis. Its two edges arise from the palmar eminences of the carpus, which are formed on the radial side by the trapezium and the pyramidal bones, and on the ulnar side by the pisiform and unciform bones.

ARTICLE SECOND.

MUSCLES OF THE SHOULDER.

§ 1108. The muscles of the shoulder, which surround the scapula and which extend from this bone and also from the clavicle to the humerus, are the deltoides, the supraspinatus, the infraspinatus, the teres major, the subscapularis, the teres minor, and the coracobrachialis muscles.

I. DELTOIDES, OR THE EXTENSOR OF THE ARM.

§ 1109. The deltoides muscle, *Sus-acromio-humeral*, Ch. (*M. deltoides, levator, attollens humeri*), is a very strong muscle, which occupies

the upper and anterior part of the region of the shoulder. It arises by its upper longest and concave edge from the anterior edge of the scapular end of the clavicle, from the anterior edge of the acromion process, and from the lower edge of all the spine of the scapula at its anterior part, by fibres almost entirely fleshy or which at least have very short tendons, and by very long tendinous fibres at its posterior.

After leaving this point, the muscle gradually becomes thicker, goes downward, and terminates by a fleshy summit externally, but possessing within a very long tendon, which is attached directly below the tendon of the pectoralis major muscle, at the posterior end of the external linea aspera, which arises from the outer tubercle of the humerus and at the central part of the outer face of this bone, which presents in this place a triangular impression.

These fibres converge from above downward; so that the central are straight, the anterior oblique from before backward, and the posterior from behind forward.

In examining this muscle more attentively, we recognize that it is composed of two orders of triangular fasciculi. The first order contains four fasciculi, which are larger than the others, and the bases of which are turned upward and their summits downward. Between are the three smaller fasciculi of the second order, which are broader below than above, but the two ends of which are a little narrower than the central part.

Below the upper edge of this muscle, between it and the capsular ligament, we find a considerable mucous bursa, which corresponds usually to the acromion, extends between this last process and the proper anterior ligament of the shoulder, and sometimes divides into two bursæ, one of which is situated near the corocoid process.

The deltoid muscle raises the arm and separates it from the side of the body.

§ 1110. A remarkable analogy with the structure of the mammalia is the existence of a posterior slip, entirely distinct from the rest of the muscle, which we have found several times. This slip arises from the tendinous expansion of the infraspinatus muscle (§1112) and from the centre of the inner edge of the scapula, by a broad and thin tendon, and is attached to the tendon of the deltoides. In most mammalia, in fact, the deltoides divides into a clavicular and a scapular portion, and the latter is subdivided into an acromial and a spinous portion.

We more frequently find the posterior part of the muscle simply separated from the anterior. We ought also to place among these anomalies the existence of a head, which goes from the anterior edge of the scapula to the deltoides,* and which is still more analogous with a part of the deltoides in birds.

* Albinus, p. 422.

II. ROTATORS OUTWARDLY.

I. SUPRASPINATUS.

§ 1111. The *supraspinatus* muscle, *Petit sus-scapulo-trochiterien*, Ch., is a triangular muscle which fills the supraspinal fossa, and is formed of fibres which converge from behind forward, from below upward, and from within outward. At first it is rather thick but gradually becomes thinner. It arises from all the supraspinal fossa, from that part of the posterior edge of the scapula situated above the spine, and from the posterior part of the upper edge and also from the upper face of this spine. It changes under the acromion process, directly below the large proper ligaments of the scapula, into a short and strong tendon, which, passing below the capsular ligament of the scapulo-humeral articulation, which it contributes to strengthen, goes to attach itself to the upper and inner part of the outer tubercle of the humerus.

This muscle turns the arm outward and raises it.

II. INFRASPINATUS.

§ 1112. The *infraspinatus* muscle, *Grand sus-scapulo-trochiterien* Ch., arises from all the infraspinal fossa of the scapula, except its lower part. It goes outward and forward, so that its upper fibres are transverse, and the lower become more oblique forward and upward the lower they are. Its thickness gradually increases as it proceeds outwardly, and it terminates in a strong tendon which extends farther on the posterior than on the anterior face. This tendon adheres to the capsular ligament of the shoulder which it strengthens, blends above with that of the preceding muscle, and is attached to the central part of the outer tubercle of the humerus.

We find a large mucous bursa between the scapula and this tendon.

This muscle draws the humerus backward and downward, and rotates it from within outward.

III. TERES MINOR.

§ 1113. The *teres minor* muscle, *Plus petit sus-scapulo-trochiterien*, Ch., is quadrangular, and is scarcely distinguished from the preceding. It arises from the central part of the posterior lip of the anterior edge of the scapula, and goes directly before the lower and anterior edge of the infraspinatus muscle forward, outward, and downward, where, gradually becoming narrower but thicker, it terminates by a short and strong tendon at the lower part of the outer tubercle of the humerus, and at the outer ridge of the humerus which descends from this tubercle.

It acts like the preceding, but it draws the humerus more outward.

III. ROTATORS INWARD.

SUB-SCAPULARIS.

§ 1114. The *subscapularis* muscle, *sous-scapulo-trochinien*, Ch., the strongest of the two muscles which turns the humerus on its axis inward, occupies all the lower face of the scapula. Its upper fibres descend obliquely outward and forward, the central are transverse, and the inferior are very oblique from behind forward and from within outward. It gradually contracts to a considerable degree, passes behind the upper end of the coraco-brachialis, and the short head of the biceps muscle, and terminates in a short, flat, and thick tendon, which is attached to all the circumference of the inner tubercle of the humerus.

Its structure is very complex, and we may reduce it to two orders of fasciculi which are more or less evidently distinct. The first, commonly five in number, arises by a tendinous summit along the inner lip of the posterior edge, and the asperities which are found on the anterior face of the scapula. The lower, which is also the strongest, forms the lower and outer part of the muscle. All progressively enlarge, and are attached to the upper tendon.

We find the second layer between them: this also is formed of five fasciculi, of which the upper likewise forms the upper part of the muscle. These fasciculi are generally stronger and broader externally, and pointed inwardly. They come from the spaces between the eminences, whence the former arise.

These two layers however interlace more than once, and we cannot insulate them without cutting their fibres. The third layer, which is described in most works on anatomy, does not in fact exist.

This muscle has two mucous bursæ. The larger is sometimes united with the capsular ligament of the scapulo-humeral articulation, and is situated on the neck, and at the base of the coracoid process of the scapula. The smaller, which does not always exist, is situated much lower and further forward, between the capsular ligament and the tendon of the muscle.

The subscapularis muscle draws the arm towards the trunk, turns it on its axis from without inward, and depresses it when it is raised. If the arm is fixed it can carry the scapula outward.

II. TERES MAJOR.

§ 1115. The *teres major* muscle, *Scapulo-humeral*, Ch. (*M. teres*, s. *rotundus major*, s. *deprimens humerum rotundus*) arises from the lower and triangular part of the outer face of the scapula, and from the posterior lip of the anterior edge, where it usually adheres to the subscapularis and teres minor muscles; but it soon leaves these two muscles and ascends, always much less obliquely than the teres minor, from which

t is separated by the long portion of the biceps, between the latter and he coraco-brachialis, approximates the humerus, and is attached by ather a short, broad, but thin tendon, to the inner rough line, directly ehind and a little below the latissimus dorsi.

Its form is the same as that of the teres minor, but it is at least twice s large as that muscle.

We find below and forward, between its tendon, the latissimus dorsi uscle, and the humerus, a small mucous bursa, and besides these, we lso find one or more in its anterior tendon where it divides.

This muscle draws the humerus backward, downward, and inward; hen the arm is turned outward, it brings it a little inward.

§ 1116. It is often united with the posterior part of the latissimus orsi muscle by a large fasciculus which leaves its posterior extremity.

IV. CORACO BRACHIALIS.

§ 1117. The *coraco-brachialis* muscle, *Coraco-humeral*, Ch. (*M. raco-brachialis*, s. *coracoideus*, s. *perforatus Casserii*) is formed like ı oblong triangle. United above, rather intimately, and to some tent, to the origin of the short portion of the biceps flexor muscle 1120), it arises from the coracoid process farther forward than the tter. It is tendinous before, in most of its length, and fleshy behind.

quitting the short portion of the biceps muscle it goes inward, comes thicker at its central part, but contracts much at its lower d, and is attached, partly fleshy, partly tendinous, to the middle gion of the inner face of the humerus.

The musculo-cutaneous nerve generally perforates it in its centre. ; lower part often blends with the upper end of the brachialis internus scle, a curious fact, as it adds a new feature to the analogy between flexors of the fore-arm and those of the leg. We find one imper- t bursa, and sometimes two, between its upper tendon, that of the rt portion of the biceps muscle, and the capsular ligament of the pulo-humeral articulation.

This muscle approximates the humerus and the scapula to each er, carries the arm to the side of the body, and rolls it a little out- rd, when it is turned inward.

Sometimes, instead of a simple perforation, it presents a real fissure, ich is often confined to its lower part, and sometimes exists its ole length, so that the tendons are separated, although the musculo- aneous nerve passes constantly between the two portions. This angement establishes a striking similarity with the structure of the s.

ARTICLE THIRD.

MUSCLES OF THE ARM.

§ 1118. The muscles found on the humerus arise partly from this bone, others from the scapula, and are attached to the bones of the fore-arm. They are the triceps extensor, the biceps flexor and the brachialis internus; the first is situated at the posterior and outer part of the arm; the other two are placed on its anterior and inner face.

I. TRICEPS EXTENSOR.

§ 1119. The *triceps extensor* muscle, *Scapulo-olecranien*, Ch. (*M. triceps brachii, cubiti*, s. *brachieus externus*, s. *posterior*) occupies most of the posterior face of the humerus, and extends from the scapula to the olecranon process.

The long or the posterior head (*caput longum, anconæus longus*) arises by a short, flat, and thick tendon, directly before the anterior insertion of the teres minor muscle, from the upper end of the anterior edge of the scapula, and goes from above downward, gradually increasing in thickness. The tendon descends very low on its inner face. Its lower tendon extends in all its lower half along the inner part of its inner face, and the fleshy fibres are inserted in it obliquely. Its form is elongated.

The large head, or the outer head, (*caput externum*, s. *magnum, anconæus magnus*, s. *externus*) arises above by a thin extremity which terminates by a convex edge, and presents very short tendinous fibres. This end is attached, directly below the insertion of the teres minor muscle, at the upper part of the posterior face of the humerus. The fleshy fibres come also from all the anterior edge of the bone. This head descends as far as the outer condyle, by a short tendon, which is oblique from above downward, from before backward, and from without inward, unites backward, and inward to the lower tendon of the long head. In all its lower portion its inner and posterior part is covered by the common lower tendon of the brachialis internus muscle. Its form is that of an elongagted rhomboid, its breadth exceeds its thickness,

The short or internal head arises, directly below the upper extremity of the preceding, from most of the posterior face of the humerus, and descends along the inner edge of the bone to near the inner condyle, rests, by its posterior and inner edge, upon the tendons of the teres major and coraco-brachialis muscles, and also the inner edge of the brachialis internus. Its fibres go obliquely downward and outward; they are attached to the lower tendon of the long head in all the lower part of the short head.

The common lower tendon of these three heads, which covers them outwardly at their lower part, is not destitute of fleshy fibres except in a very small portion of its extent below, and is inserted in the upper broad edge of the posterior face of the olecranon process of the ulna.

We find a considerable mucous bursa between this tendon and the olecranon process, besides which we sometimes find two smaller ones on each side. We less commonly see another, also smaller, above.

This muscle extends the articulation of the elbow and usually moves the fore-arm; but it can also move the arm when the fore-arm is fixed. The long head brings the scapula towards the humerus, and draws the latter inward and backward.

II. BICEPS FLEXOR.

§ 1120. The *biceps flexor* muscle, *Scapulo-radial*, Ch. (*flexor antibrachii biceps*, s. *radialis*, s. *biceps internus*), is a very long muscle, situated on the anterior and the outside of the arm, and extends its whole length. Its two heads are separated above in almost all the muscle, and extend from the scapula, whence they arise, to the upper extremity of the radius.

The internal, posterior, or short head (*caput breve*), called also the *coraco-brachialis* muscle, from one of its attachments, is not only shorter but also thinner than the long head. It arises from the coracoid process by a short, flat, and narrow tendon, which it has in common with the coraco-brachialis muscle, more forward and outward than the latter, proceeds on its outside a little obliquely from within outward, covers below the inner and upper part of the brachialis internus muscle, and lower down becomes a tendon, which is first seen on its external face, on the side corresponding to the long head. This tendon, which unites to that of the last, is attached to the tuberosity of the radius.

The *long head* (*caput longum*, s. *M. gleno-radialis*) arises by a long, thin, and flat tendon from the centre of the upper part of the edge of the glenoid cavity of the scapula. This tendon is inclosed in a special fold of the capsule of the scapulo-humeral articulation, which answers as a mucous sheath, passes upon the head of the humerus, and is situated in the groove between the two tuberosities of this bone, where it is retained by the fibres of the fibrous ligament of the shoulder-joint, and on the anterior extremity of which the mucous sheath ceases. It thus comes to the anterior and outer side of the arm, where it soon continues with its fleshy belly but deeper than the tendon of the short head. This latter descends above, along the anterior and external edge of the biceps extensor muscle; below, before the central part of the brachialis internus muscle: at its lower extremity it is attached on one side, that is by its internal face, to the tendon of the short head; on the other to a peculiar tendon contained within it, and which when entirely destitute of fleshy fibres is united with that of the first head, being inserted at the same place with it.

We find a large mucous bursa between the lower tendon, that of the supinator brevis and the tuberosity of the radius, to which sometimes a smaller is added, situated on the outer face of the tendon.

The principal use of this muscle is to flex the articulation of the elbow. It also turns the fore-arm backward, contributes to draw it inward when it is extended, and depresses the scapula toward the humerus.

§ 1121. The biceps flexor muscle is one of those muscles most subject to variation, and presents the most singular anomalies.

The least considerable anomaly is where the two heads arise much lower than usual, so that they are only united by the inferior tendon.*

A greater anomaly, which is not rare, is when a third head exists, which is usually smaller than the other two, and which arises near the centre of the internal face of the humerus,† more rarely from only the brachialis internus muscle,‡ although it is often blended with it. Sometimes also it is united with the coraco-brachialis muscle. This anomaly is very remarkable, as it is a repetition of the small head, which properly belongs to the biceps femoris muscle, and because its union with the coraco-brachialis muscle makes the number of the long flexors of the fore-arm equal to those of the long flexors of the leg. At the same time it approximates man to animals; since in birds the long flexor of the fore-arm presents a second smaller head, which arises from the lower tuberosity of the humerus; while in apes the brachialis internus muscle extends much higher.

The number of heads of this muscle sometimes increases still more, so that we number five; but these are not inserted in one common inferior tendon.§ At the side of the third, which is most usually met with we sometimes find a fourth, and along the tendon of the short head a fifth, which unite and are attached to the radius below the usual tendon; in this case, consequently, there were in fact three flexors, as is always found in birds.

III. BRACHIALIS INTERNUS.

§ 1122. The *brachialis internus* muscle, *Humero-cubital*, Ch. (*M. flexor cubitalis ulnaris*, s. *brachieus internus*), a broader and thicker muscle, especially at its posterior part, which entirely covers the inferior portion of the internal and anterior faces of the humerus, arises by an external and an internal slip, the former being higher, from the external and internal faces of the humerus above its centre. These two slips surround the lower extremity of the deltoides muscle; the internal extends to the coraco-brachialis and the external to the upper

* Weitbrecht. *Comment. Petrop.*, 1731.—Albinus, *loc. cit.*—Rudolphi, in *Gantzer*, 6.—We have seen it several times but always on one side.

† Albinus, *loc. cit.*, p. 438, 439.—Mayer, *loc. cit.*

‡ Kelch, *loc. cit.*, p. 35.

§ Pietsch, in *Roux Journal de Med.*, vol. xxxi. p. 215.

extremity of the large head of the triceps extensor muscle. Its anterior edge descends along the external edge of the humerus, and the posterior along the internal edge of this bone to the part where it suddenly enlarges.

Its fibres are attached to a strong rounded inferior tendon, which reascends on the anterior face of the muscle almost to its centre. This tendon is inserted in the tuberosity of the ulna.

Between the tendon of the brachialis internus, that of the biceps flexor cubiti, the supinator brevis muscle, and the capsular ligament, we find a mucous bursa, which is not however constant.

This muscle flexes the articulation of the elbow.

§ 1123. We sometimes find at the side of it, but more forward and outward, a second brachialis internu smuscle, which is smaller, and which is an exact repetition of it as respects its attachments, the inferior tendon of which is inserted deeper than that of the other, and which even presents a rudiment of the preceding muscle, which we said belonged to birds. The first degree of this anomaly is the separation of the posterior from the anterior part of the muscle, which not unfrequently occurs. This division of the brachialis internus muscle into two parts is also worthy of remark, as it assimilates this muscle to the flexors of the leg. Its adnormal union with the biceps flexor by a muscular slip (§ 1121) is on the contrary the first index of the formation of a third head to the latter (§ 1121).

The anomalies of the brachialis internus, the biceps flexor, and the coraco-brachialis muscles (§ 1116). considered collectively, seem to be so many efforts by which nature endeavours to establish a perfect resemblance between the upper and lower extremities. They are generally found singly; but if we suppose them united, we have an arrangement perfectly similar to that of the lower extremities,

The coraco-brachialis and brachialis internus muscles, divided into two portions and often united with each other, evidently represent the semimembranosus and the semitendinosus muscles. The muscular band which goes from the brachialis internus to the lower part of the biceps flexor muscle, united with the unusually deep division of the latter, may be considered as tending to insulate the two heads and to form a second flexor of the ulna, even as the tibia is flexed by two distinct muscles.

ARTICLE FOURTH.

MUSCLES OF THE FORE-ARM.

§ 1124. The muscular mass of the fore-arm is formed of those muscles which move the bones upon each other or on the humerus, by the muscles which act on the carpus, and by the long muscles of the fingers. The motions of the bones of the fore-arm on each other, or pronation and supination, are performed by four muscles, the supinator longus

and the supinator brevis, the pronator teres and the pronator quadratus, all of which except the first are situated deeper than the other muscles of the fore-arm.

The two bones of the fore-arm are moved on the humerus by one muscle, the anconeus.

Five muscles move the carpus; the extensor carpi radialis longus and the extensor carpi radialis brevis extend it: it is flexed by the flexor carpi ulnaris and the flexor carpi radialis muscles; the extensor carpi ulnaris draws it backward.

The fingers are extended by the extensor digitorum communis, the extensor pollicis longus and brevis, the extensor indicis proprius, and the extensor minimi digiti proprius; they are flexed by the flexor sublimis, the flexor profundus, and the flexor pollicis longus.

These different muscles succeed each other in the following order, when we commence their description at the radial edge and follow the external face of the fore-arm to the ulnar edge, and return from this to the radial edge along the internal face of the arm.

I. MUSCLES OF THE INTERNAL FACE OF THE FORE-ARM.

I. SUPINATOR LONGUS.

§ 1125. The *supinator longus* muscle, *Humero-sus-radial*, Ch., is a long muscle, which arises by short tendinous fibres from the inferior part of the anterior edge of the humerus, where it unites with the large head of the triceps extensor muscle. It goes downward and passes on the inferior and external part of the brachialis internus, which it covers, and reaches the fore-arm along and before the inferior extremity of this muscle: it goes on the radial edge of the fore-arm and is changed high up into a long and thin tendon, which covers above only the internal face, and is finally attached to the anterior face of the internal edge of the radius, a short distance above its inferior face. It turns the radius backward and inward, consequently carries the hand to the state of supination, and flexes the fore-arm.

II. EXTENSOR CARPI RADIALIS LONGUS.

§ 1126. The *extensor carpi radialis longus* muscle, *Humero-sus metacarpien*, Ch., resembles the preceding and appears at first view to be a part of it. It arises from the lowest part of the outer edge of the humerus, descends to the outer condyle, passes on the outer part of the articular edge of the humerus, and on the head of the radius; in its course it becomes first thicker, afterward narrower, and terminates at the same place as the preceding in a tendon, at first rather broad, flattened, and loose to a much greater distance, which descends in the same direction along the radius and enters below into the anterior groove of the outer face of the lower extremity of the radius under the posterior ligament of the carpus, thus arrives at the carpus and is attached to

the anterior part of the posterior face of the base of the second metacarpal bone.

The lower tendon is surrounded with a mucous sheath where it passes over the lower extremity of the radius. We also find a small bursa at its insertion in the root of the second metacarpal bone.

This muscle extends the hand and draws it a little toward the radial side of the fore-arm; it also serves to execute the motion of pronation to a certain extent and flexes the articulation of the elbow.

§ 1127. Sometimes a smaller and feebler muscle is detached from its lower edge, which succeeds the extensor carpi radialis brevis muscle and is attached a little above it to the root of the third metacarpal bone.*

III. EXTENSOR CARPI RADIALIS BREVIS.

§ 1128. The *extensor carpi radialis brevis* muscle, *Epicondylo-sus-metacarpien*, Ch., is very similar to the preceding, but is smaller. Its upper tendon, which is very strong, exists nearly the whole length of its posterior face. It arises from the anterior face of the outer condyle of the humerus, and is attached, below the middle of the fore-arm, by an elongated, flat, but narrow tendon, the upper part of which covers the lower part of the outside of the muscle. This tendon is inserted in the outer face of the base of the third metacarpal bone, and slightly also in that of the second. There is a small bursa between it and the third metacarpal bone.

This muscle acts in the same manner as the preceding.

§ 1129. It is sometimes entirely deficient,† as in several mammalia, where we never find but one extensor radialis muscle; the first degree of this formation is the complete union of the second radialis muscle, of which several instances are known. Sometimes its tendon divides into two slips, which are attached to the third metacarpal bone only, or one is inserted into this bone, and the other into the next; even as in the mammalia, which have only one radialis muscle, the tendon divides into two slips.

Besides the bursæ already mentioned, the tendons of the two muscles are surrounded by two common sheaths, the upper of which is situated above the lower end of the radius, while the lower is placed at a short distance from it on this extremity, and on the upper range of the carpal bones.

IV. EXTENSOR DIGITORUM COMMUNIS.

§ 1130. The *extensor digitorum communis* muscle, *Epicondylo-sus-phalangettien commun*, Ch., commences by a strong tendon, which

* Albinus, *loc. cit.*, p. 448.

† J. G. Salzmann, *Diss. sist. plurium pedis musculorum defectum*, Strasburg, 1784, p. 11.

extends on the upper part of the external face of its belly. It arises from the lower and back part of the outer condyle of the humerus, directly under and behind the radialis externus brevis muscle, with which it is intimately connected for several inches. Near the centre of the fore-arm it separates into three bellies, the posterior of which also divides a little farther in two others, so that the whole number of these bellies is four; these are inserted into as many elongated and flat tendons, of which the second is usually the strongest, the third smaller than the first, and the fourth is the weakest.

All these tendons pass under the posterior ligament of the carpus, between it and the outer face of the lower end of the radius. They become broader and thinner on the back of the hand, partially separate, especially near the anterior end of the metacarpus, and are again united by strong oblique intermediate tendons of various breadths. They go to the second, third, fourth and fifth fingers, and contract on the articulation of the metacarpus with the phalanges; but in this place they give off on each side fibres, which go downward; farther on they again enlarge, and are blended on each side with the tendons of the interosseous muscles. On the first joint of the phalanges they divide into a central and two lateral portions, which are much longer; the central tendon, having strengthened the dorsal face of the capsular ligament, is attached to the upper edge of the base of the second phalanx; the other two are united forward, and are inserted in the upper part of the back of the third phalanx.

At the lower end of the fore-arm, of the carpus and metacarpus, the tendons of this muscle have a mucous sheath, which is single above, but divides on the carpus into three branches, each of which goes with its tendon to the base of the first phalanx.

This muscle extends the second, third, fourth, and usually the fifth finger also.

§ 1131. Sometimes its three bellies are separated high up, and even at their origin.* Sometimes it divides into four tendons; the fourth goes to the little finger, and unites to its proper extensor. This fourth tendon sometimes divides on the back of the hand into two parts; the outer joins the tendon of the extensor minimi digiti proprius muscle, and the inner again divides into two portions, one of which unites to the tendon of the fourth finger, and the other to that of the fifth.† In some subjects the third and fourth tendons go to the third finger. In this case the muscle itself often divides into two bellies, each of which has two tendons.‡

These divisions of the fleshy part of the muscle are curious, being similar in one respect to the extensors of the toes and also to the flexors of the fingers, which are both double.

* Albinus, *loc. cit.*, p. 452.—Brugnone, *loc. cit.*, p. 167.
† Albinus, *loc. cit.*
‡ Brugnone, *loc. cit.*

V. EXTENSOR MINIMI DIGITI PROPRIUS.

§ 1132. The *extensor minimi digiti proprius* muscle, *Epicondylo-sus-phalangettien du petit doigt*, Ch., is slender, elongated, and thin. It arises by two tendinous heads from the outer part of the head of the radius, from the part of the capsular ligament surrounding this head, and from the upper end of the anterior edge of the ulna. It descends behind the preceding, with which it is closely united for some distance, and near the lower end of the fore-arm becomes a thin tendon, which passes below the posterior ligament of the carpus in a special groove, enlarges along the metacarpal bone of the fifth finger, unites inward with the fourth tendon of the preceding muscle, and is attached to the upper face of the head of the third phalanx of the little finger.

Its tendon is surrounded from the lower part of the fore-arm to the centre of the fifth metacarpal bone by a sheath, which is single above, but below divides like the tendon into two parts.

This muscle extends the little finger.

§ 1133. It is sometimes deficient,* and then it is generally replaced by a tendon of the extensor digitorum communis muscle. In other cases, on the contrary, its tendon divides into two slips, one of which goes to the fourth finger, an arrangement worthy of remark because of its analogy with several mammalia.

VI. EXTENSOR CARPI ULNARIS.

§ 1134. The *extensor carpi ulnaris* muscle, *Cubito-sus-metacarpien*, Ch. (*M. ulnaris externus*, s. *extensor manus ulnaris*), arises by two tendinous slips, of which the smaller and shorter is situated at the side of the extensor digitorum communis, and comes from the posterior and lower part of the external condyle of the humerus, and the longer arises from the upper part of the anterior face of the tubercle of the ulna. These two slips soon unite in a considerable belly. The latter is tendinous at its inner and outer faces, and adheres in a considerable extent to the extensor proprius minimi digiti muscle, descends along the outer face of the ulna, from which it receives some fibres, and becomes, near the lower third of the fore-arm a strong tendon, which, passing across a particular portion of the dorsal ligament of the carpus comes on the back of the hand, where it is attached to the tubercle of the metacarpal bone of the fifth finger. There is but one mucous bursa between its upper extremity and the head of the radius.

This muscle extends the hand and draws it backward toward the posterior edge of the fore-arm.

§ 1135. A tendon of greater or less extent is often detached to go to the fifth finger, and at the base of the first phalanx unites with that of its proper extensor.

* Bauchone, p. 167.—We have known two instances where it was deficient.

VII. ANCONŒUS.

§ 1136. The *anconæus* muscle, *Epicondylo-cubital*, Ch. (*M. anconæus*, s. *anconæus quartus*), is a triangular muscle and mostly covered by the upper extremity of the preceding; it arises by a short and strong tendon from the inner part of the outer condyle of the humerus, descends toward the ulna, and is attached by a broad fleshy surface to the upper part of the anterior face of this bone. Its upper straight edge usually blends with the outer belly of the triceps extensor muscle.

This muscle extends the fore-arm, also turns the radius backward, so that it assists in supination.

VIII. SUPINATOR BREVIS.

§ 1137. The *supinator brevis* muscle, *Epicondylo-radial*, Ch., is triangular; its base looks upward, and its apex downward. It arises from the upper part of the anterior face of the ulna, and is tendinous outwardly and fleshy inwardly. Its upper fibres are transverse and the lower oblique. It goes downward and forward, turns on the upper part of the radius, and is attached by a broad fleshy edge to the anterior part of the capsule of the ulna, and also to the upper part of the anterior and inner faces of the radius as far as its posterior edge. It turns the head and the radius on their axes backward and outward.

§ 1138. The upper part of this muscle often separates from the lower sooner than usual, and differs from it in the direction of its fibres, is separated from it by the radial nerve, and is attached to the radius without being connected with it. This anomaly leads to that in which two small supinator muscles exist; the upper extending from the outer condyle of the humerus to the anterior edge of the upper end of the radius, while the internal goes from the head of the radius to its centre.* Probably the second variety may be considered as an index of the formation peculiar to apes; in which three supinators exist.†

IX. ABDUCTOR POLLICIS LONGUS.

§ 1139. The *abductor pollicis longus* muscle, *Cubito-sus-metacarpien du pouce*, Ch., is a considerable muscle inserted, by very short tendinous fibres, directly below the anconeus and the supinator brevis, to the second fifth of the anterior edge of the ulna, to the outer face of the interosseous ligament, and to the central part of the outer face of the radius. It descends along the last, passes below on the anterior face of the radius, and there becomes a strong tendon, which passes

* Sandifort, *Hist. musc.* p. 93.—Burgnone, *loc. cit.* p. 163.

† We have found at least in the *Simia apella* two long supinators, situated at the side of each other.

through a particular divison of the dorsal ligament of the carpus. This tendon generally divides into two or three slips : the strongest, which is also the most anterior, is attached to the radial edge of the base of the first metacarpal bone ; the other two blend with the posterior extremity of the antagonist muscle of the thumb.

The tendon near its upper extremity is surrounded by a large, oblong, and rounded mucous sheath.

This muscle separates the thumb from the fingers, and moves it toward the radius.

§ 1140. It is often more or less divided into two bellies, each of which terminates by a tendon, and the lower is usually larger than the upper. The tendons of these two bellies are often divided, and sometimes unite ; sometimes they are attached to the first bone of the metacarpus and to the trapezium.*

We more rarely find a digastric abductor of the thumb, which arises from the outer condyle of the humerus, and is inserted into the base of the first phalanx of the thumb.

X. EXTENSOR POLLICIS BREVIS.

§ 1141. The *extensor pollicis brevis* muscle, *Cubito-sus-phalangien du pouce*, Ch., is a very small muscle, situated below the preceding, and adheres intimately to its inferior edge. It arises from the outer face of the interosseous ligament and from the radius, and becomes a very thin tendon, which passes through the dorsal ligament of the carpus in the same groove with the abductor pollicis longus, then goes on the back of its metacarpal bone, becomes broader, and is attached to the centre of the upper edge of the base of its first phalanx.

This muscle extends the thumb, and at the same time removes it from the other fingers.

§ 1142. A small tendon sometimes arises from the anterior extremity of its tendon, which blends with that of the next muscle.

Sometimes this muscle does not exist as a distinct muscle, and forms only the lower part of the abductor pollicis longus muscle.

XI. EXTENSOR POLLICIS LONGUS.

1143. The *extensor pollicis longus* muscle, *Cubito-sus-phalangetien du pouce*, Ch. (*M. extensor pollicis major*, s. *longus*), is much longer than the preceding, and covers its upper part ; it arises a little below the abductor magnus, and directly below its upper extremity, above from the outer face and below from the anterior edge of the ulna, and from the adjacent part of the external face of the interosseous ligament. It soon becomes a long tendon, which passes through the second groove of the dorsal ligament of the carpus, goes forward at the side of the preceding, but much more inwardly, partially covers it, and

* Fleischmann, in the *Erlanger Abhand.*, vol. I. p. 28.

is attached to the base of the second phalanx of the thumb, in the same manner as the tendon of the extensor digitorum communis is; but it does not divide.

Its tendon has two mucous sheaths: the upper and larger is situated at the lower part of the fore-arm, and extends to the carpus; the inferior is smaller, and is placed on the carpus and on the base of the first metacarpal bone.

It extends the thumb, and brings it a little towards the other fingers.

§ 1144. Sometimes it is completely double.

XII. EXTENSOR INDICIS PROPRIUS.

§ 1145. The *extensor proprius indicis* muscle, *Cubito-sus-phalangettein de l'index*, Ch. (*M. indicator*, s. *indicatorius*, s. *indicis extensor*, s. *abductor*), is nearly as large as the preceding. It arises directly below it by two slips from the third quarter of the anterior face of the ulna, and near the lower part of the fore-arm becomes a strong tendon, which, covered by that of the extensor digitorum communis, passes with it through the third division of the dorsal ligament of the carpus, below the tendinous band which goes from the latter muscle to the indicator finger; it proceeds more inwardly than this band, and is attached to the base of the first phalanx of the finger, blending with it.

It extends the indicator finger, and approximates it a little towards the third.

§ 1146. Sometimes it is digastric, and interrupted in its course by a long tendon.*

This muscle presents several anomalies which are exceedingly interesting: they consist in its more or less perfect multiplication and in the formation of the extensor pollicis tertii proprius.

The lowest degree of this anomaly is the division of its portion into two slips both of which go to the second finger,† or the division of its belly into two parts, the tendons of which unite before arriving at this finger,‡ or finally the existence of two bellies of the usual size, which are entirely distinct, and of which one arises from the radius.§

The most complete anomaly is when one of the slips of the tendon does not go to the indicator, but to the middle finger.‖

Sometimes a small and perfectly distinct muscle arises from the lower part of the outer face of the radius and from the dorsal ligament of the carpus, and is attached to the first phalanx of the indicator.¶ This variety is only a more perfect development of the case in which the muscle arises by two heads.

Next, comes the anomaly where we find a proper extensor of the middle finger; this muscle is always smaller than the extensor indicis

* Rosenmüller, *loc. cit.*, p. 6.
† We have seen it several times.
‡ Albinus, p. 458.—Heymann, p. 13.
§ Gantzer, p. 14.
‖ Albinus, p. 468.—Peitsch, *Sylloge obs. anat.*
¶ Albinus, *Ann. acad.*, vol. iv. ch. vi.—Heymann, p. 12.

proprius, and arises more or less below or under it. This formation varies the least possible from the normal state when the new muscle comes from the ulna;* but sometimes it arises from the radius† or from the dorsal ligament of the carpus.‡

The greatest anomaly is where we find, beside the extensor indicis proprius, an extensor for the middle finger, which divides into two tendons, one of which is attached to the metacarpal bone of the index finger, and the other to that of the middle finger.

Finally, we have seen in one case a small tendon, which extended from this proper extensor of the middle finger to the base of the first phalanx of the index finger.§

All these anomalies are curious in two respects: 1st, as a repetition of the normal formation of the lower extremities, since they represent the extensor communis digitorum brevis, and that more perfectly as the supernumerary muscles arise lower; 2d. as analogous with animals; for in many apes the tendon of the extensor indicis proprius furnishes a slip to the middle finger, and in others, for instance in the simia capella, we find a proper extensor of the index finger.

II. MUSCLES OF THE INTERNAL FACE OF THE FORE-ARM.

I. PALMARIS LONGUS AND BREVIS AND THE PALMAR APONEUROSIS.

§ 1147. The *palmaris longus* muscle, *Epitrochlo-palmaire*, Ch., is a thin oblong muscle, which arises directly below the preceding and farther back than it, from the upper part of the anterior face of the inner condyle of the humerus. It goes directly forward and downward, and becomes in the middle of the fore-arm a broad and thin tendon, which is very near the skin. This tendon however is covered by the anti-brachial aponeurosis in most of its length, and passes over this aponeurosis only at its lower part. At its lower end, it divides into two fasciculi: the anterior, which is shorter, and which is attached to the posterior end of the abductor pollicis; and the posterior, which is much larger and is called the *palmar aponeurosis* (*aponeurosis palmaris*). This aponeurosis is thinner than the tendon, but much broader and triangular. It gradually enlarges from behind forward, so that it corresponds by its anterior edge to the four fingers. It however becomes thin, and its fibres occasionally have intervals between them.

It is composed essentially of longitudinal fibres, like the tendon of which it is the expansion. Its anterior edge is however formed of transverse fibres, which are arranged over the preceding.

It covers most of the muscles of the palm of the hand, except those of the thumb and the little finger.

* We have seen it several times.
† We have seen it once.
‡ Brugnone, *loc. cit.*, p. 168.
§ Meckel, *Beytrage zur vergleichenden anatomie*, vol. ii. p. 11.

The *palmaris brevis* muscle, which is composed of transverse fibres, is attached to its internal edge at its upper part. This muscle, the internal edge of which comes from the skin, serves to tense the aponeurosis outwardly.

§ 1148. The palmaris longus muscle is often deficient; sometimes it is replaced by a tendon of the flexor digitorum sublimis.* In other cases, on the contrary, it is unusually developed, in fact thinner, but very broad, and descends almost into the palm of the hand.† This rudiment of a peculiar muscle, which sometimes extends from the coronoid process of the ulna to the palmar ligament of the carpus, is worthy of remark, especially as it forms an analogy with apes.‡

II. RADIALIS INTERNUS.

§ 1149. The *radialis internus* muscle, *Epitrochlo-metacarpien*, Ch. (*M. radialis internus*, s. *flexor manus radialis*), is much larger than the preceding, and is blended above with it and on both sides with the pronator-teres and the flexor communis digitorum sublimis; it comes from the anterior face of the inner condyle of the humerus, and sometimes also by a small head from the radius. It is partly covered by the preceding, and goes downward and a little forward, and near the middle of the fore-arm becomes a broad tendon. This tendon passes under the palmar ligament of the carpus in a special canal, formed by the palmar ligament, and by the os trapezium; it is harder and thicker in this place than in other parts. After leaving this canal it becomes thinner but broader, and is attached partly to the os trapezium, but more particularly to the inner face of the second metacarpal bone.

We find a mucous bursa between the lower end of the tendon, the os trapezium, and the proper palmar ligament.

This muscle flexes the hand and carries it a little forward.

III. PRONATOR TERES.

§ 1150. The *pronator teres* muscle, *Epitrochlo-radial* Ch., a shorter but stronger muscle, arises by very short tendinous fibres from the upper edge and the upper part of the anterior face of the inner condyle of the humerus. It swells a little below its origin, goes obliquely downward and forward, and is covered at its lower part and at its upper edge by a strong tendinous expansion, and is attached by means of this, below the supinator brevis, and before the abductor pollicis longus, to the anterior face and outer edge of the radius, a little above its centre.

It turns the radius and also the hand inward, forward, and downward.

* Rosenmüller p. 6.
† Albinus, p. 474.
‡ Perrault, *Mem. in Valentini Theatr. zool.* p. 151. Vicq. d'Azyr. *Encycl. meth. sect., anat.* vol. ii. p. 25, 257.

§ 1151. It is sometimes double. In this case the supernumerary muscle extends from the posterior edge of the ulna to the posterior edge of the normal muscle, which is an analogy with apes.

IV. FLEXOR ULNARIS.

§ 1152. The *flexor ulnaris* muscle, *Cubito-carpien*, Ch. (*M. ulnaris internus*, s. *flexor ulnaris*), arises by two rather short heads, of which the upper comes from the lower part of the inner face of the inner condyle of the humerus, and the posterior or the inferior from the inner face of the olecranon process of the ulna. It descends along the ulna, from which it is always separated by the flexor digitorum communis, and becomes a strong tendon at the lower end of the fore-arm which is attached to the pisiform bone ; we find a very loose mucous bursa between it and this bone.

It flexes the hand and inclines it toward the ulna.

V. FLEXOR DIGITORUM COMMUNIS SUBLIMIS.

§ 1153. The *flexor digitorum communis sublimis* muscle, *Epitrochlo-phalanginien commun*, Ch. (*M. flexor digitorum communis sublimis*, s. *perforatus*), arises below the four preceding, by a much larger head, from the lower part of the anterior face of the inner condyle of the humerus, from the inner part of the capsular ligament of the elbow joint, and from the inner face of the coronoid process of the ulna ; it also arises by a small slip from the inner face of the radius at the lower end of the supinator brevis muscle. Long before this slip has joined the upper head, it divides into three bellies, of which the internal and posterior divide still lower into two others. Each of these bellies becomes a tendon, which all pass under the special palmar ligament of the carpus to arrive at the palm of the hand.

Nearly opposite the centre of the first phalanx each tendon divides into two slips which unite farther on the second phalanx, so that their inner fibres interlace and again separate below this point to attach themselves behind the middle of the second phalanx to its radial and ulnar edges.

These tendons are surrounded by a common sheath, near the lower extremity of the fore arm, which, when arrived at the carpus, divides into several sacs, each of which goes with one of them to the base of the first phalanx. This muscle flexes the second phalanx of the fingers.

§ 1154. One of the tendons, particularly that of the little finger, is sometimes deficient ; it is then replaced by one of the tendons of the flexor profundus muscle ; sometimes a belly of this muscle, especially that which belongs to the index finger, is entirely separated from the others, and divided besides into two fleshy portions by a long central tendon. As the anomaly is seen more commonly in the belly of the indicator finger, it is worthy of remark, from its analogy with the outer

face of the fore-arm, since it represents the proper extensor of the index finger, and more, as the latter is also digastric in some subjects.

VI. FLEXOR DIGITORUM PROFUNDUS.

§ 1155. The *flexor digitorum profundus* muscle, *Cubito-phalangettein commun*, Ch. (*M. flexor digitorum communis profundus*, s. *suadus perforans*), is stronger than the preceding, which covers it anteriorly, and arises from the upper two-thirds of the inner and posterior faces of the ulna, so as to envelop this bone almost entirely, and divides, but much deeper than the flexor sublimis, into four bellies, which become as many tendons. These tendons are retained together by numerous intermediate filaments and by folds of the mucous sheaths, and pass under the palmar ligament of the carpus, with those of the preceding, and go to the same fingers. In this place we see a fissure along the upper and lower faces. They pass through the sheath of the flexor sublimis, afterwards become broader and thinner, and are attached to the base of the third phalanx.

This muscle flexes the third phalanx of the fingers.

§ 1156. Sometimes a muscle proceeds between the flexor sublimis and the flexor profundus, and extends from the inner condyle of the humerus to the latter;* and again, a muscular fasciculus arises from the flexor pollicis longus as high as the wrist, which is attached by a tendinous expansion to that tendon of the flexor profundus which goes to the index finger.†

VII. LIGAMENTS OF THE FLEXORS OF THE FINGERS.

§ 1157. The tendons of the flexor profundus and sublimis are surrounded in two places by fibrous ligaments and mucous sheaths.

§ 1158. The upper fibrous ligaments are the common palmar ligament and proper palmar ligament of the carpus.

Below them we find the upper mucous sheath, an elongated sac, which surrounds all the tendons of the two flexors, commences about an inch and a half above the radio-carpal articulation, and extends to the centre of the carpus. Its outer layer is attached to the palmar ligaments of the bones of the carpus, and to the interossei muscles. Numerous folds arise from all the internal face of this outer layer which go inward, surround the tendons of the two flexors, and unite but very loosely.

§ 1159. The second place, where the common flexors are surrounded with similar ligaments, is that portion which corresponds to the lower face of the fingers.

§ 1160. The lower fibrous ligaments are situated outwardly, and form for the mucous sheath an envelop, which is divided on account of the motion of the fingers.

* Gantzer, p. 13.
† Gantzer, *ibid.*

The strongest portion is termed the *ligamentous sheaths (Lig. vagi-alia)*. These sheaths are formed almost entirely of transverse bres; in part, however, especially on the surface, of oblique fibres hich cross the preceding. They are strongly extended, like a bridge om the radial to the ulnar edge of the first and second phalanges. hat of the indicator finger is much stronger than the others in every spect.

The feeblest which stand more distinct, extend in the same manner er the metacarpo-phalangœan and the second phalangœan articula-ons. Their size diminishes much from the first to the third articula-on. They are called the *ligamentous rings of the articulations nnuli junctvrarum ligamentosi*).

Analogous fasciculi are found between the preceding and the liga-ntous sheaths; these are the *oblique* or *crucial rings of the first and ond phalanges* (*annuli obliqui*, s. *cruciati phalangis primæ et undæ*).

§ 1161. The inner faces of these fibrous ligaments are covered with ngated mucous sheaths, which begin some lines behind the meta-po-phalangœan articulation, are attached in this place to the flexor blimis and profundus of each finger, and extend to the centre of the minating phalanx. Their upper part is inserted in the upper part the palmar face of the phalanges. The tendons of the two flexors mostly loose in these mucous sheaths, of which each finger sesses a separate one; however, from the dorsal face of the sheaths, t which covers the palmar face of the fingers, arise several broader l narrower irregular folds, the largest of which contains more or fat; these proceed from before backward, are very thin from one to the other, and are attached to the tendons of the flexor limis and profundus. The upper are usually very thin and rounded, are attached to the radial slip of the flexor sublimis. They are erally deficient in one or several fingers.

he succeeding which are larger are also more constant; they e near the second phalangœan articulation, and are usually attached he tendon of the flexor sublimis, where its two slips unite. Usually find also within or on their sides other prolongations, which go to tendons of the flexor profundus.

third prolongation generally arises from the base of the third lanx which is attached directly to the two anterior slips of the or sublimis, unites them, goes from this point to the anterior ex-nity of the flexor profundus which covers the third articulation, is there attached in all its extent.

ther single or divided prolongations extend also in many parts ween the tendons of the two flexors in their course along the ers.

hese are the *short* and *long accessory* or *vascular ligaments of the ers (vincula tendinum sublimis et profundi accessoria*, s. *vasculosa ia et longa*).

VIII. FLEXOR POLLICIS LONGUS.

§ 1162. The *flexor proprius pollicis longus* muscle, *Radio-phalangettien du pouce*, Ch., is much feebler and shorter than the preceding, with the second belly of which its central part usually adheres more or less intimately. It arises by a small distinct slip from the tubercle of the ulna, but in most of its length it arises by fleshy fibres from the lower two-thirds of the inner face, and the anterior edge of the radius. The strong tendon which terminates it passes under the palmar ligament with those of the two preceding muscles, and goes between the abductor and flexor pollicis brevis on the internal face of this finger, and is attached not far from its inferior edge to the second phalanx. This tendon is surrounded by a special mucous sheath from the lower extremity of the fore-arm to the centre of the first phalanx.

It flexes the second phalanx of the thumb.

We sometimes find a second head which comes from the inner condyle of the humerus, and which is only a greater development of its upper slip.

IX. PRONATOR QUADRATUS.

§ 1163. The *pronator quadratus* muscle, *Cubito-radial*, Ch. (*M. pronator quadratus*, s. *inferior*), is an almost equilateral quadrilateral muscle, being rather more long than broad, which occupies the lowest part of the inner face of the fore-arm, where it is covered by the tendons of all the long muscles. Its fibres are oblique and extend from the posterior edge and from the inner face of the ulna to the inner face and anterior edge of the radius.

This muscle rotates the radius, and the hand with it, on its axis from behind forward and from without inward.

§ 1164. It is sometimes deficient,* as in several mammalia.

Again, it is sometimes divided into two bellies, which are entirely separated, the fibres of which proceed in opposite directions and cross.†

ARTICLE FIFTH.

MUSCLES OF THE HAND.

§ 1165. The muscles of the hand‡ arise from the tendons of the flexor profundus, from the carpus, and from the metacarpus, and are attached to the metacarpal bones and also to the phalanges. They are principally designed to approximate and separate the fingers and serve less

* We know of one instance.
† We have once seen this.
‡ Albinus, *Icones musculorum manus*, iv., *ad calcem hist. musc.*, Leyden, 1734.

o flex them. Hence they are divided into abductors, adductors, and exors. The adductors and abductors which are attached to the two xternal fingers, the thumb and the little finger, fulfil only the one or he other of these two functions, while those which move the other ree fingers are both adductors and abductors; because, in approxi-ating a finger toward that on one side, they necessarily separate it om that of the other side.

The abductor and adductor muscles of the fingers, except the thumb, e called the *interossei* muscles, from their situation; the flexors of e second and third and also one of the little finger are called the *lum-icales*, from their form.

I. LUMBRICALES.

§ 1166. The four *lumbricales* muscles, *Palmi-phalangien*, Ch., are ng, rounded muscles, which arise fleshy from the lower face and the dial edge of the tendons of the flexor digitorum profundus toward e upper end of the metacarpus. They proceed at the side above and low these tendons and arrive at the fingers, where they become thin ndons, which are reflected on the radial face of the first phalanx, large, and blend with the anterior edge of the tendon of the extensor uscle.

They flex the first phalanx.

§ 1167. We often find one or more of these muscles more or less npletely double, and then the supernumerary head or the whole scle is inserted in the ulnar side of the adjacent finger.

II. INTEROSSEI.

1168. The *interossei* muscles, *Metacarpo-phalangiens lateraux sus-maire* and the *metacarpo-phalangiens lateraux*, Ch., are situated ween the metacarpal bones. Their anterior tendons are attached tly to the lateral faces of the posterior heads of the first phalanges, tly also to the extensors of the fingers. They are divided into two ses, the *external* (*M. interossei externi*, s. *bicipites*), and the *internal* *interossei interni*, s. *simplices*.

II. INTEROSSEI EXTERNI.

1169. The common characters of the external interossei muscles 1st. They appear on the dorsal and palmar faces of the hand. They arise from the corresponding faces of two metacarpal es by two heads, which are inserted in a common tendon.

ve number four, which are attached to the index, middle, and little ers.

he first, which is the strongest, is situated between the thumb and index finger, It differs from the others, not only in volume but in the complete separation of its two heads.

The anterior and stronger head arises from the upper larger part of the ulnar face of the metacarpal bone of the thumb. The posterior, which is smaller, arises from almost all the radial face of the second metacarpal bone. These two heads unite below in a common tendon, which is attached partly to the radial face of the base of the first phalanx of the index finger, and partly blends with the tendon sent by the common extensor of the same finger.

The great distance between the two heads has led some anatomists to consider them as two distinct muscles : they have termed the anterior head the *adductor indicis*, and the posterior the first internal interosseous muscle.

It draws the second finger toward the thumb.

The other external interosseous muscles are much smaller ; their heads unite much higher even in the centre of their course.

The second arises by a smaller anterior and deeper head from the ulnar side of the second, and by a larger posterior looser head from the radial side of the third metacarpal bone. It is also attached to the radial side of the middle finger.

This muscle brings the middle finger toward the index finger.

The third, situated in the space between the third and fourth metacarpal bones, is inserted in the ulnar side of the middle finger.

It brings the middle finger toward the fourth.

The fourth is placed between the fourth and fifth metacarpal bones, and is inserted in the ulnar side of the fourth finger.

It brings the ring finger to the fifth.

II. INTEROSSEI INTERNI.

§ 1170. The *interossei interni* muscles are three in number, when we do not consider the posterior head of the first external interosseous muscle as the first internal interosseous muscle. They are attached to the second, fourth, and fifth fingers. They arise by a single head from the lateral face of the metacarpal bone of the finger to which they are attached, and are very distinct in the palm of the hand.

The first arises from the ulnar face of the second metacarpal bone, is inserted in the ulnar side of the base of the first phalanx of the indicator finger, and blends in the same place with the tendon sent by the common extensor to this finger. It separates the index finger from the thumb and draws it toward the middle finger.

The second comes from the radial side of the fourth metacarpal bone.

The third arises from the radial side of the fifth metacarpal bone.

The second is attached to the first phalanx of the fourth finger, and the third to the first phalanx of the fifth finger.

Both draw the fingers to which they are attached from the side of the thumb or from the radial edge of the hand, and consequently inward.

The index finger has then an external and an internal interosseous muscle; the middle finger has two external interosseous muscles; the fourth nger an external and an internal, and finally the fifth finger an internal interosseous muscle.

§ 1171. The interosseous muscles rarely present anomalies. We have however found the second external interosseous muscle attached to the ulnar side of the index finger, and the first internal interosseous muscle attached not to this finger but to the radial side of the third—a variety the more interesting in the history of the inversion of the organs because it presents an exact repetition of the normal formation of the foot, and because the hand in which we found it presented also an adductor of the thumb, formed likewise in the same manner as that of the great toe.

III. MUSCLES OF THE THUMB.

§ 1172. The metacarpal bone of the thumb is surrounded by a considerable muscular mass, called the ball of the thumb (*thenar*), formed of four muscles, the abductor pollicis brevis, the opponens pollicis, the flexor pollicis brevis, and the adductor pollicis.

I. ABDUCTOR POLLICIS BREVIS.

§ 1173. The *abductor pollicis brevis* muscle, *Carpo-sus-phalangien du pouce*, Ch., the most superficial of the four muscles, arises from the anterior part of the inner face of the ligament of the carpus and of the os trapezium. It is generally blended by a short intermediate tendon with the tendon of the abductor longus (§ 1139), and extending forward along the radial edge of the metacarpal bone of the thumb, it is attached by a short tendon to the outer face of the posterior head of its first phalanx. It also usually blends more anteriorly with the tendon of the flexor pollicis brevis muscle.

It separates the thumb from the index finger and extends it a little.

II. OPPONENS POLLICIS.

§ 1174. The *opponens pollicis* muscle, *Carpo-metacarpien du pouce*, Ch., is smaller than the preceding, which it partly covers, and its form is rhomboidal. It arises below it by a broad edge and by very broad tendinous fibres from the anterior part of the inner face of the palmar ligament and from the os trapezium, then descends to the metacarpal bone of the thumb, and is attached by a short tendon to all the anterior part of its radial edge.

It draws the thumb inward and turns it on its axis; so that it opposes its palmar face to that of the other fingers.

II. FLEXOR POLLICIS BREVIS.

§ 1175. The *flexor pollicis brevis* muscle, *Carpo-phalangien du pouce*, Ch. (*M. flexor pollicis brevis*, s. *mesothenar*, s. *antithenar*), is stronger than the two preceding. Its upper extremity, which is very much divided, arises first below and inward from the palmar ligament and the os trapezium, on the other side from the palmar face of the os tropezoides, from the os magnum, and the os pyramidale. It partly covers the preceding and is attached to the outer sesamoid bone of the thumb.

It flexes the first phalanx of the thumb.

§ 1176. The largest head, which comes from the palmar ligament, is sometimes entirely separated from the other, which is smaller and situated lower; so that this muscle is in fact double. On the other hand, it often happens that the small head is entirely blended with the adductor pollicis muscle.

IV. ADDUCTOR POLLICIS.

§ 1177. The *adductor pollicis* muscle, *Metacarpo-phalangien du pouce*, Ch. (*M. mesothenar*, s. *hypothenar*), is the strongest and the deepest of the four muscles of this finger. Its form is triangular, the base looking toward the ulnar edge and the summit toward the radial edge. It arises by fleshy and tendinous fibres from the palmar face of the os magnum, and in a greater or less extent from the palmar edge of the third metacarpal bone, goes forward and outward, and is attached by a short tendon to the inner sesamoid bone.

This muscle draws the thumb toward the index finger and slightly rotates on its axis, so that it turns its palmar face toward that of the other fingers.

§ 1178. Sometimes it divides into a posterior and an anterior belly, which are completely distinct, the posterior being larger. In this case the first arises only from the os magnum or at the same time from this bone and a small upper portion of the third metacarpal bone: as to the second, it comes from the lower part of the anterior head of the third and fourth metacarpal bones; sometimes also from the fifth as well as from the capsular ligament of the first phalangean articulation, and goes across or a little obliquely from before backward, to the first phalanx of the thumb, where it unites with the posterior head.

This anomaly is worthy of remark, as it coincides perfectly with the normal arrangement of the adductor of the large toe.

IV. MUSCLES OF THE LITTLE FINGER.

§ 1179. The little finger is moved by three muscles, an abductor, a flexor, and an adductor.

I. ABDUCTOR MINIMI DIGITI.

§ 1180. The *abductor minimi digiti* muscle, *Carpo-phalangien du petit doigt*, Ch., the shortest of these three muscles, extends along the ulnar edge of the metacarpus. It arises by short tendinous fibres from the pisiform bone, and near the first phalanx of the finger becomes a small flat tendon, which blends with the ulnar edge of the tendon of its extensor.

It separates the little finger from the others.

II. FLEXOR MINIMI DIGITI.

§ 1181. The *flexor minimi digiti* muscle, (*M. flexor proprius digiti quinti*) is covered by the preceding. It arises below and before it from the pisiform bone and from the unciform process of the unciform bone: it forms a short tendon forward, which is attached to the radial side of the first phalanx of the little finger.

It flexes the little finger and separates it from the others.

It is often deficient and then the preceding is more developed.

III. ADDUCTOR MINIMI DIGITI QUINTI.

§ 1182. The *adductor minimi digiti* muscle, *Carpo-metacarpien du petit doigt*, Ch., (*M. adductor digiti quinti*), is thickest and shortest, and arises from the lower anterior edge and the outer face of the unciform process of the unciform bone, goes upward and is attached to all the ulnar face of the metacarpal bone of the fifth finger.

It carries the little finger forward and draws it toward the others, causing it to rotate around its axis on the metacarpal bone. When it acts in concert with the opponens pollicis muscle, which very much resembles it, the cavity of the palm of the hand enlarges.

§ 1183. The proper muscles of the thumb and little finger are only the lumbricales or interossei muscles largely developed and divided into several fasciculi. We must consider the flexor pollicis brevis muscle as the first lumbricalis. The abductor pollicis brevis and the opponens pollicis correspond to an external; the abductor represents an internal interosseous muscle.

The abductor and the flexor minimi digiti muscles form only one muscle, which represents the last external interosseous muscle.

The adductor minimi digiti muscle is only an enlarged internal interosseous muscle.

CHAPTER II.

MUSCLES OF THE LOWER EXTREMITIES.

§ 1184. The muscles which have with the upper section of the abdominal members relations similar to those which exist between the superficial muscles of the back and of the region of the shoulder, or the broad muscles of the abdomen, have already been examined. We may then pass immediately to those which go from the first section of the bones of the lower extremites to the femur; but we must here also commence by describing the general aponeurotic envelop.

ARTICLE FIRST.

APONEUROTIC SHEATH OF THE LOWER EXTREMITIES.

§ 1185. Most of the muscles of the lower extremities, especially those of the thigh, leg, and sole of the foot, are enveloped by an aponeurotic expansion, which is not arranged every where in the same manner.

This expansion is called on the thigh the *fascia lata*, on the leg the *crural aponeurosis*, in the sole of the foot the *plantar aponeurosis*.

The first two form a whole more continuous with each other than with the plantar aponeurosis, and are also still more similar in their form, as they surround the thigh and the leg.

The *fascia lata* commences behind on the gluteæus maximus muscle, where it is very thin, and gradually loses itself at its upper portion. It arises forward from the iliac crest and from the Fallopian ligament. It extends as far as the knee. It adheres very intimately by the upper and external part of its anterior edge to the lower edge of the tendon of the obliquus externus abdominis muscle, to which it is much more loosely attached on its inner side.

It is thickest at the outer part and thinnest at the inner part of the thigh. It is half a line thick in every part and above even a line in the first region, while it hardly equals the twelfth of a line in the second. In general it is evidently formed of two layers of fibres: the internal is stronger and its fibres are longitudinal; the external is weaker and its fibres are oblique downward, inward, and backward, and are more insulated, and gradually approach each other from below upward.

From the inner face of this aponeurosis arise septa which extend between most of the muscles of the thigh which they separate from each other; we readily distinguish in most of these septa transverse and oblique fibres.

The fascia lata presents oblique fibres in every part. In many places, especially at the inner portion of its circumference, these fibres are extended over a layer which is not evidently fibrous, especially forward, but at the outer part this layer is manifestly formed of longitudinal fibres, and at the same time its inner face presents in different parts more insulated oblique fibres, so that here the aponeurosis evidently consists of three layers.

The outer part of the *crural aponeurosis* is also much thicker, and formed in this part of two layers; the fibres of the internal are longitudinal, those of the external, which is weaker, are oblique.

At the upper part of the aponeurosis the direction of the oblique fibres is inversely that of the oblique fibres of the fascia lata, that is, they proceed forward, downward, and inward.

At the lower part of the crural aponeurosis they have an opposite direction, and at the same time other fibres are developed on the inner side of the aponeurosis, which are oblique from behind forward and from above downward.

These outer and inner fibres cross on the anterior face of the articulation of the foot, and as they increase in strength in this part they there form the *crucial ligament* (*Lig. cruciatum*), composed of two fasciculi, which cross each other in the centre. One of these fasciculi descends from the outer malleolus, goes downward and inward, and is attached to the tibial side of the first metatarsal bone. The second arises from the internal malleolus, and goes to the tuberosity of the fifth metatarsal bone.

Below, they are both continuous with the thin aponeurosis of the back of the foot, which covers the tendon of the extensor digitorum longus and the belly of the extensor communis digitorum pedis, and is lost near the anterior extremity of the metatarsus.

This aponeurosis at the back of the foot is often much stronger toward the posterior end of the first metatarsal bone in this place, where it passes over the tendon of the extensor proprius pollicis pedis, than in the rest of its extent, and it is formed of very evident transverse fibres, which are attached internally to the inner side of the metatarsus, and outside to a special fasciculus of the extensor brevis digitorum pedis. In this case, this portion of the aponeurosis of the foot is provided with a proper tensor muscle.

II. TENSOR VAGINÆ FEMORIS.

§ 1186. The aponeurosis of the fascia lata, like most of the aponeurotic expansions which surround the muscles, has a proper muscle called the *tensor vaginæ femoris* muscle, *Ilio-aponeurosi-femoral*, Ch. (*M. tensor fasciæ latæ*).

This muscle is situated at the anterior edge of the upper part of the lateral face of the thigh. It arises by a short but very strong tendon from the outer face of the anterior and superior spine of the ilium,

Thence it goes downward and outward, gradually enlarges, and is continuous by very short tendinous fibres, towards the summit of the middle third of the thigh, with the fascia lata, which is united with its outer face more firmly than with any other muscle.

ARTICLE SECOND.

MUSCLES OF THE PELVIS.

§ 1187. The muscles of the pelvis arise partly from its outer face, partly from its inner face, and partly from the lumbar portion of the vertebral column; they are attached to the upper part of the femur which they extend, flex, and turn around its axis.

I. EXTENSORS OF THE THIGH.

§ 1188. The thigh is extended by three muscles called the *glutæi*, situated over each other; and they cover the outer face of the iliac bones, and descend outward, downward, and forward toward the femur.

I. GLUTÆUS MAXIMUS.

§ 1189. The *glutæus maximus* muscle, *Sacro-femoral*, Ch., is the largest of all the muscles of the body, and is nearly a regular rhomboid. It arises by its posterior and inner edge from the posterior part of the outer lip of the crest of the ilium, from the lower part of the posterior face of the sacrum, from the sacro-sciatic ligament, and from the sciatic tuberosity. It arises by these different points by short tendinous fibres, goes from within outward and from above downward, forming a very strong and thick muscle, composed of distinct and large fasciculi which are loosely connected with each other. It is attached by a broad and very strong tendon which is continuous below with the lateral part of the fascia lata to the lower part of the large trochanter, and to the linea aspera which descend from this tubercle.

Several mucous bursæ are found on the inner face of the lower tendon of this muscle. The largest and at the sametime the uppermost is situated between it and the outer face of the large trochanter. Farther backward and downward we find another which is also large but a little smaller, between it the upper extremity of the vastus externus muscle and the lower end of the tensor vaginæ femoris muscle. Finally, between this muscle and the femur, farther backward and downward, are two which are smaller.

The glutæus maximus extends the thigh, brings it toward the vertebral column, rotates it a little outward, and approximates it to that of the side opposite. When it acts from below upward it draws the iliac bones downward, inward, and forward.

II. GLUTÆUS MEDIUS.

§ 1190. The *glutæus medius* muscle, *Grand ilio-trochanterien*, Ch., is a large muscle, but smaller and closer than the preceding, and has a triangular form. It is covered at its posterior and lower part by the glutæus maximus, and forward by the fascia lata only, with which it is intimately connected. It arises from the outer lip of the crest of the ilium, and from the upper and anterior part of the outer face of the iliac bones which is situated between the iliac crest and the curved line. Its posterior fibres are oblique from behind forward and from without inward; the anterior go from above downward. It proceeds towards the large trochanter, and is attached to its outer face by a broad, short, and very strong tendon, which blends with that of the glutæus maximus muscle.

A small mucous bursa exists between the upper face of this muscle, the pyriformis, the gemellus superior, and the inner face of the large trochanter.

The glutæus medius muscle raises the femur, separates it from that of the opposite side, and inclines the pelvis as much as possible towards its side.

Its posterior part turns the thigh outward, and its anterior turns it inward.

II. GLUTÆUS MINIMUS.

§ 1191. The *glutæus minimus* muscle, *Petit ilio-trochanterien*, Ch., has the same form as the preceding, while it is much smaller and is entirely covered by it. It arises directly below it by its upper face and anterior edge from the curved line, and from the anterior and lower part of the outer face of the iliac bones. It is attached by a short and strong tendon to the upper edge of the upper part of the inner face of the large trochanter.

A small synovial capsule exists forward between it and the large trochanter.

Its action is the same as that of the preceding.

II. MUSCLES WHICH ROTATE THE THIGH OUTWARDLY.

§ 1192. The thigh is turned outward by six muscles, the pyriformis the obturator internus, the obturator externus, the two gemelli, and the quadratus femoris.

I. PYRIFORMIS.

§ 1193. The *pyriformis* muscle, *Sacro-trochanterien*, Ch. (*M. pyriformis*, *pyrimidalis*, *iliacus externus*), is a small muscle of an oblong

triangular form coming from the cavity of the abdomen, where it arises by three or four digitations from the sacrum. It arises from the anterior face of this bone, between the third and fourth, the second and third, and the first and second pairs of the anterior foramina of the sacrum, and from the inner face of the posterior and lower spine of the ilium, and from the upper part of the posterior edge of the iliac fossa. It descends through this last behind the upper part of the descending branch of the ischium, goes outward and forward, and is attached by a rounded, strong, and proportionally broad tendon to the summit and upper part of the inner face of the large trochanter.

There is a small mucous bursa between its tendon and the gemellus superior muscle.

It rotates the thigh outward, separates it from that of the side opposite, and raises it a little.

§ 1194. It sometimes divides into an upper and a lower portion, between which the glutæal nerve passes.*

II OBTURATOR INTERNUS.

§ 1195. The *obturator internus* muscle, *Sous-pubio-trochanterien interne*, Ch. (*M. obturator internus*, s. *marsupialis*, *marsupialis internus*), arises from the inner face of the obturator foramen by radiating fibres, which suddenly change their direction on leaving the pelvis and turn at a right angle on the posterior face of the descending branch of the ischium, covered before by this part of the bone, and behind by the sacro-sciatic ligament. It then proceeds outward and forward, and is attached by a strong tendon to the central part of the inner face of the great trochanter, far below the tendon of the pyriformis muscle.

The arrangement of this tendon is then very peculiar. It begins within the pelvis, a short distance from the descending branch of the ischium, but extends to about the centre of the space between the ischium and the trochanter. It does not appear except on the anterior and inner face of the muscle, where it consists of five very regular and very distinct fasciculi, two of which form the upper and lower edge of the muscle. The outer extremity of the middle belly extends between them by four triangular fasciculi, and then immediately unite in a strong tendon near the centre of the space between the ischium and the great trochanter.

We find an oblong synovial capsule backward and outward between the tendon of this muscle, the gemelli, and the great trochanter. A second, external and rounded, situated between the schiatic spine and the great trochanter, surrounds the inner part of the tendon.

The obturator internus muscle turns the thigh directly outward and draws it from that of the opposite side.

* Winslow, *Expos. anat.*, vol. ii. p. 125.

III. GEMELLI.

§ 1196. The *gemelli* muscles, *Ischio-trochanterien*, Ch. (*M. gemini femoris, marsupiales externi, marsupium*), are two small oblong muscles, which are very similar and placed one over the other: they are separated backward and outward by the tendon of the obturator internus muscle, also by that portion of this muscle which is situated out of the pelvis. Their thin edges touch forward.

The *upper* arises by a pointed extremity from the lower part of the posterior face of the ischiatic spine.

The *lower* arises by a broad and semilunar edge from the upper face of the sciatic tuberosity and from the outer face of the descending branch of the ischium. It gradually becomes thicker from within outward.

These two muscles are intimately connected with the obturator internus, especially in their outer portions, entirely cover it, and are attached with it to the inner face of the great trochanter.

They act in the same manner as the preceding.

§ 1197. The upper gemellus is frequently deficient*—a remarkable analogy with what is seen in the ape.†

We know of one case where both these muscles were deficient, as in bats.

IV. QUADRATUS FEMORIS.

§ 1198. The *quadratus femoris* muscle, *Ischio-sous-trochanterien*, Ch., is oblong and composed of transverse fibres. It is broader from without inward than in any other direction, and its height much exceeds its thickness. It arises from the anterior edge of the sciatic tuberosity and from a small part of the ascending branch of the ischium, passes directly below the gemellus inferior to the posterior face of the femur, where it is attached to a square impression situated between the roots of the large and small trochanters above the posterior intertrochanterian line.

We find a synovial capsule between it and the small trochanter.

It acts like the preceding.

§ 1199. Sometimes it does not exist.‡ More rarely it is divided into several fasciculi, three of which have been known to exist.§

V. OBTURATOR EXTERNUS.

§ 1200. The *obturator externus* muscle, *Sous-pubio-trochanterien externe*, Ch., is a rounded and triangular muscle, at first thin, but after-

* Gantzer, p. 4.

† Vicq. d'Azyr, *Enc. méth. syst. anat. des quadrup.*, p. 29.

‡ Albinus, *loc. cit.*, p. 530.—We know of one case where the gemelli were very large.

§ Jancke, *De caps. tend. articul.*, Leipsic, 1753.

wards it becomes thicker, and again grows thinner. It arises by a rounded edge from the outer face of the ascending branch of the ischium and by short tendinous fibres from the two branches of the pubis and from the anterior face of the obturator membrane.

After contracting considerably in its outer portion and being covered by a broad tendon on its anterior and posterior faces, it is reflected from the anterior to the posterior face of the body, goes obliquely upward and outward directly behind the neck of the femur, and is attached by a short but very strong tendon to the fossa and to the inner face of the great trochanter, a little distance below the tendons of the obturator internus and the gemelli muscles.

It turns the thigh outward, draws it backward toward that of the opposite side, and brings the anterior face of the pelvis to its side.

III. FLEXORS OF THE THIGH.

§ 1201. There are two flexors of the thigh, the psoas magnus and the iliacus internus muscles: to these a third is usually attached, the psoas parvus muscle; but this does not always descend to the thigh.

I. PSOAS MAGNUS.

§ 1202. The *psoas magnus* muscle, *Prelombo-trochanterien*, Ch. (*M. psoas magnus*, s. *lumbaris*, s. *lumbaris internus*), is a considerable elongated and rounded muscle, occupying the inner and anterior part of the lumbar region directly on the side of the bodies of the lumbar vertebræ. It extends from the upper extremity of this region downward and outward to the inner face of the femur.

It arises by an external and posterior and an internal and anterior range of short, flat, and triangular slips from the five lumbar vertebræ and the last dorsal.

The anterior slips come from the lateral faces of the short ligaments and the intervertebral ligaments; the posterior arise from the lower and anterior parts of the transverse processes of the lumbar vertebræ.

The belly of this muscle descends outward, covers the inner part of the iliacus internus, becomes rounded as it descends, and forms before the sacro-iliac articulation, rather outward than inward, a strong tendon which emerges from the abdomen below the crural arch behind the femoral vessels, and is attached to the anterior face of the small trochanter.

The psoas magnus muscle bends the thigh and turns it a little inward, bends the trunk and turns it a little toward its side.

§ 1203. Between this muscle and the iliacus internus we sometimes find another smaller, which arises from one or more transverse processes of the upper lumbar vertebræ, proceeds on the outside of the psoas magnus muscle, and is attached to the small trochanter and

sometimes to the tendon of the last. The crural nerve usually passes between it and the psoas magnus muscle.* This anomaly reminds us of the multiplication of the psoas magnus muscle in several apes.†

This and not the next muscle, as some anatomists assert, is the muscle which sometimes exists abnormally.‡

II. PSOAS PARVUS.

§ 1204. The *psoas parvus* muscle, *Prelombo-pubien*, Ch., has an oblong square form, and arises from the lateral face of the first lumbar vertebra, and from the intervertebral ligament between it and the last dorsal vertebra, and sometimes from the twelfth dorsal vertebra. It arises generally by one but sometimes by two slips, which come either from the two vertebræ or only from the first lumbar.

It soon after becomes a flat and very long tendon, situated on the outside of the psoas magnus muscle, crosses it to go inward, and is attached in that part where the body of the pubis and ilium unite.

Below, the tendon becomes an aponeurosis, which covers the lower part of the psoas magnus and of the iliacus, is attached to the crural arch, and blends with the fascia lata.

This muscle bends the vertebral column forward and increases the force of the two muscles situated above it, furnishing them with a point of support.

§ 1205. It is sometimes deficient, but this is rare.

III. ILIACUS INTERNUS.

§ 1206. The *iliacus internus* muscle, *Iliaco-trochanterien*, Ch. (*M. iliacus*, s. *iliacus internus*), is a broad and considerable muscle, which fills all the upper part of the inner face of the iliac bones, whence it descends to the inner part of the thigh. It arises by a semicircular and convex edge and by short tendinous fibres from the inner lip of the iliac bone, and also by fleshy fibres from the inner face of this bone to near the anterior and inferior iliac spine, goes inward and forward, becomes in its course considerably narrower and thicker, and is attached a little above the crural arch to the outside of the tendon of the psoas magnus muscle, by which it is fixed to the anterior face of the small trochanter.

We find a considerable mucous bursa between the common tendon of the psoas magnus and the iliacus internus muscle and the capsular ligament of the coxo-femoral articulation. There is another, which is smaller, between it and the small trochanter.

This muscle bends the thigh and carries it inward. It draws the pelvis and with it the trunk downward and forward.

* We have seen it several times.—Albinus, p. 315.
† Valentine, *Amph. zoot.*, p. 151.
‡ Kelch, *Beytræge zur path. anat.*, p. 22.

ARTICLE THIRD.

MUSCLES OF THE THIGH.

§ 1207. Among the muscles which form the mass of the thigh some serve to move it and others act on the leg. Not only the first but also some of the second arise from the bones of the pelvis.

The muscles of the first class are the adductors of the thigh ; those of the second are the adductors, the flexors, and the extensors of the leg.

I. ADDUCTORS OF THE THIGH.

§ 1208. The two lower limbs are drawn toward each other by the *adductors* (*adductores*), which form almost all the internal and posterior part of the muscular mass of the thigh. Three of these muscles in particular have been termed the adductors. They have been considered as forming only a single muscle, called the *triceps* muscle (*M. femoris triceps*), but wrongly, as they are not united by a common tendon. The fourth has been described as a separate muscle called the *pectinæus*, although it might be considered as a fourth head of the common adductor, as well as the other three.

1. PECTINÆUS.

§ 1209. The *pectinæus* muscle, *Sous-pubio-femoral*, Ch. (*M. pectinæus*, s. *pectinalis*), a flat, long, quadrangular muscle, arises by its upper thin and horizontal edge from the crest of the horizontal branch of the pubis, on which its upper and anterior face passes. It goes from above downward, from within outward, and is attached by a perpendicular edge to the upper end of the inner lip of the rough line of the femur.

We find a small synovial capsule below the small trochanter, between this muscle and the femur.

It draws the thigh toward that of the opposite side, raises it and carries it forward, turns it a little inward, and slightly inclines the pelvis outward and downward.

§ 1210. We sometimes find a second pectinæus, which is smaller, which blends below with the tendon of the other, and is attached above to the inner part of the upper edge of the obturator foramen.*

§ 1211. The three adductors, properly so called, are distinguished into the long, the short, and the great adductor.

II. ADDUCTOR LONGUS.

§ 1212. The *adductor longus* muscle, *Pubio-femoral*, Ch. (*M. adductor femoris longus, caput primum tricipitis*), has the form of an ob-

* Winslow, *Expos. anat.*, vol. i. p. 117.

long triangle. It is the second of the three adductors in size and the longest of all. It arises by a short, narrow, but very strong tendon from the inner part of the anterior face of the horizontal branch of the pubis, from the spine of the pubis, and from the anterior part of the symphysis pubis. Thence it goes outward and downward, in a direction more oblique than the preceding, becomes broader and at the same time thinner, and is attached by a tendinous and interrupted edge to the third quarter of the posterior lip of the rough line of the femur. Its lower end usually unites to the vastus internus muscle.

Its action is nearly the same as that of the pectinæus.

§ 1213. It is sometimes divided into two. And again, it descends much lower, by a thin tendon united to that of the adductor magnus: so too in some mammalia and in birds the pectinæus or the other portions of the adductor muscle descend very low.

III. ADDUCTOR BREVIS.

§ 1214. The *adductor brevis* muscle, *Sous-pubio-femoral*, Ch., (*M. adductor femoris brevis*, s. *adductor secundus*, s. *caput alterum tricipitis*), is rather a broad triangular muscle. It arises at the side of the tendon of the gracilis muscle, but much higher and more externally than it, and is closely united with its upper extremity. Its upper end situated directly below the adductor longus and formed of very short tendinous fibres, arises from the inner part of the outer face of the horizontal branch of the pubis. It is much broader and much shorter than the preceding, goes less obliquely outward than it, and is attached to the posterior face of the small trochanter and also to the upper third of the inner lip of the rough line of the femur, by several strong tendinous slips, which succeed each other from above downward.

At its lower extremity it is connected more or less intimately with the pectinæus and the adductor magnus muscles.

It acts like the preceding.

§ 1215. It is often partially or wholly divided into two slips, which forms a remarkable analogy between man and the ape.

IV. ADDUCTOR MAGNUS.

§ 1216. The *adductor magnus* muscle, *Ischio-femoral*, Ch. (*M. adductor femoris magnus*, s. *caput tricipitis tertium*), is the largest of the three proper adductor muscles; it also has a triangular form, the base of which rests in the thigh, and the apex looks toward the pelvis. It arises from the anterior face of the descending branch of the pubis, and is intimately connected in this part with the outer face of the lower part of the tendon of the gracilis muscle. It arises also from the ascending branch of the ischium and from the lower edge of the sciatic tuberosity.

Its upper and anterior fasciculi go directly downward and outward. The posterior and inferior on the contrary, which are attached to the

sciatic tuberosity, go from below upward, around and behind the latter, so that the muscle seems at its upper part to have been twisted on itself, and is much thicker there than in the rest of its course.

Before the extremity of the portion inserted in the sciatic tuberosity, the upper edge, which is loose and fissured in a semilunar form, goes toward the femur, where it is attached to the posterior lip of the linea aspera, behind the pectinæus and the other two adductors, always descending deeper than they. The lower tendon is very strong, particularly at its lower part, and extends to the posterior face of the inner condyle of the femur.

About the latter fourth of the thigh this tendon is perforated by the superficial vessels of the leg, which pass from its anterior to its posterior face. It unites below to the vastus internus muscle.

This muscle draws the thigh inward, carries it forward, turns its anterior face a little outward, flexes the pelvis forward, and directs its anterior face to the side.

§ 1217. We sometimes find it divided into two portions as in apes.

II. MUSCLES OF THE THIGH WHICH MOVE THE LEG.

§ 1218. The muscles situated on the thigh forming its mass, and which move the leg, are distinguished into adductors, extensors, and flexors.

I. ADDUCTORS OF THE LEG.

§ 1219. Those nearest the surface are the adductors, of these there are two, the sartorius and the gracilis.

A. SARTORIUS.

§ 1220. The *sartorius* muscle, *Ilio-pretibial*, Ch., the longest of all the muscles of the body, is very thin, and has an elongated square form. The short tendon by which it arises descends lower on its external than on its internal edge. It is inserted directly at the side of the tensor vaginæ femoris muscle, more inward and forward, on the anterior and upper spine of the iliac bone. Thence it passes onward and inward, above the lower part of the adductor longus and adductor magnus muscles. In this manner it attains the anterior face of the thigh, where its lower portion goes to the inner face of the same part Thence it proceeds directly forward and at the side of the gracilis, and soon becomes rounder and narrower, and forms a short rounded tendon, which passing behind and below the inner condyle of the femur, comes to the inner face of the leg. In this place it rests directly on the upper part of the inner face of the tibia, it becomes broader, and is attached by its anterior edge to the inner face of this bone, near its spine, and is contiguous below with the aponeurotic expansion of the leg.

This muscle flexes the knee, and when this articulation is bent it turns the tibia inward, so that the end of the foot approaches the other. When it acts in an opposite direction it draws the haunch a little forward and turns it inward.

§ 1221. We have met with one subject in which the sartorius muscle did not exist.

Sometimes, on the contrary, there are two which may happen in several different ways.* The normal muscle usually appears curved inward, and the additional muscle terminates sooner below, where it is attached either to the tendon of the first or to the femur.

Sometimes the fibres of the sartorius muscle are interrupted by a considerable intermediate tendon which is firmly united to the fascia lata.†

B. GRACILIS.

§ 1222. The *gracilis* muscle, *Sous-pubio-pretibial*, Ch. (*M. gracilis*, s. *rectus internus*), is a thin muscle of an oblong triangular form which arises by a broad base which forms its upper edge, from the anterior face of the lower portion of the descending branch of the pubis, and from the upper part of the ascending branch of the ischium. Thence one of its edges turns forward and the other backward, one of its faces outward and the other inward; it goes to the inside of the thigh, and above its latter sixth, becomes a thin and rounded tendon, which proceeds directly behind the lower part and the tendon of the sartorius, and turns with it on the inner condyle of the femur. It is at first covered by it, and is then situated below it, and blended with it in its anterior and inferior part, and is finally inserted a little lower down, on the upper part of the inner face of the tibia.

It bends the knee, turns the leg inward, and draws the anterior face of the iliac bones from the side to which it is attached.

II. EXTENSORS OF THE LEG.

§ 1223. The leg has four extensors which may very properly be considered as one muscle with four heads, since they are attached to a common tendon. They are situated directly below the fascia lata aponeurosis on the anterior face, and on the sides of the thigh, and form most of its muscular mass. A considerable mucous bursa exists between them and the aponeurosis of the thigh. They are termed the rectus femoris, the vastus internus, the vastus externus, and the crureus muscles.

A. RECTUS FEMORIS.

§ 1224. The *rectus femoris* muscle, *Ilio-rotulien*, Ch. (*M. rectus femoris*, s. *extensor cruris medius superficialis*), is a strong elongated

* Huber, *Act. n. c.*, vol. x. p. 114.—Rosenmüller, *loc. cit.*, p. 7.—Gantzer, p. 14.
† Kelch, *loc. cit.*, p. 42, p. xxxv.

pointed muscle situated on the anterior face of the thigh, directly under the fascia lata aponeurosis in most of its length, except its upper part, where it is covered by the sartorius muscle.

It arises by two points from the iliac bone by a very strong but short tendon. In fact, this tendon is divided above into two heads, an *upper* anda *lower* or *external* tendon.

The *upper head*, which goes directly downward, comes from the anterior and inferior spine of the ilium. The lower, which is curved ina semicircle, arises from the upper part of the edge of the cotyloid cavity. These two heads soon unite to give rise to the upper common tendon. This tendon soon disappears on the posterior part of the muscle, but becomes much broader on the anterior, and descends to its centre, gradually becoming thinner.

The central fleshy portion is composed of an outer and an inner layer of fibres, which unite at an acute angle on the median line, so that the arrangement of these fleshy fasciculi resembles in some measure a roof.

The fibres are much longer, and ascend much straighter the nearer they are to its lower extremity. They are attached on both sides to a prolongation of the upper tendon, the direction of which is from beforebackward, which descends into the substance of the muscle from its anterior face, and gradually diminishes from above downward. It however continues perceptible to near the lower end of the fleshy belly, that is, much lower than the broad and anterior part of the upper tendon descends on its outer face. It is nowhere connected with the posterior and inferior tendon.

The lower tendon is much longer but is weaker than the upper. It ascends on the posterior face of the muscle, much higher than the upper, descends on the anterior, so that the fleshy belly is situated for several inches before and behind between two tendinous expansions. It begins to be visible forward only towards the lower third of the thigh, and is seen first on the two sides of the fleshy belly, which gradually contracts. It is entirely loose after quitting the last fifth of the thigh. When approaching the patella below, it becomes broader, and is attached to the upper edge of this bone, and is intimately united with the tendons of the other extensors.

This muscle extends the leg when the thigh is fixed, and the thigh when the leg is fixed ; in the latter case it also bends the pelvis a little and turns its anterior face obliquely to the opposite side.

D. VASTUS EXTERNUS.

§ 1225. The *vastus externus* muscle, (*M. extensor cruris vastus, s. externus,*)* the largest of all the extensors of the leg, although much shorter than the preceding, forms almost solely the muscular mass on the outside of the thigh; at the same time it extends very much

* This and the next two muscles are termed the *Trifemoro-rotulien* by Chaussier.

backward and forward. It is considerably thick, but it is broader from before backward than from within outward.

It arises by a slightly concave edge which inclines from before backward, from within outward, and from above downward, from the lower part of the anterior and outer face of the great trochanter. The upper half of its posterior edge, situated along the rough line of the femur, comes from the inner face of the outer wall of the fascia lata aponeurosis. From all these points it gradually descends forward, becomes narrower, and is finally attached, by an inferior tendon, to the upper and outer edge of the patella. The inner part of this tendon is covered some distance above its insertion by the tendon of the rectus femoris muscle, to which it is even slightly united, although it is easily separated from it as far as where it is inserted in the patella.

The muscular fasciculi go directly downward. The upper tendon extends below the centre of the muscle on its outer face, and the lower only to the centre of its inner face.

The vastus externus muscle extends the knee, and most generally raises the leg at the same time, and turns it a little outward.

C. VASTUS INTERNUS.

§ 1226. The *vastus internus* muscle, (*M. extensor cruris*, s. *vastus internus*) is a little shorter and much weaker than the preceding, with which it is blended outwardly in a small portion of its upper extremity. It arises by its upper edge, which descends obliquely inward, from the anterior intertrochanterian line; by a small part of its lower edge, from a part of the anterior face of the femur situated below this line; and by the upper part of its posterior edge, from the upper part of the anterior lip of the linea aspera. Its lower tendon is attached to the inner part of the upper edge, and to the inner edge of the patella. The inner part of this tendon is covered below by that of the vastus externus which passes obliquely over it, and is attached to the patella before it; it adheres to this tendon but is easily separated from it.

The upper tendon of this muscle descends over almost the whole of the inner and loose face on the posterior half of the muscle, while the lower disappears already below the centre of its outer face, principally at its upper part.

This muscle extends the leg and turns it a little inward.

D. CRURÆUS.

§ 1227. The *cruræus* muscle, (*M. cruralis*, s. *cruræus*, s. *femoræus*) the shortest of the four extensors of the leg, is also nearly as strong as the preceding. It arises by its posterior and inner face, directly below this last, from the larger part of the anterior and the outer face of the femur, excepting a small portion above, and from its lower third. The posterior edge comes from the outer lip of the linea aspera. This

muscle covers also most of the anterior and outer faces of the femur. It is attached by its lower tendon behind the vastus internus and the vastus externus to the upper edge of the patella, and usually also at its lower and outer part, by short fibres, to the synovial capsule, and to the outer edge of the patella.

This lower and outer part is generally separated from the others, particularly from their tendon.

The upper edge of this muscle is attached to the bones without any appearance of a tendon. The lower tendon, the loose portion of which is longer than that of the two preceding, begins on the contrary from the middle of the anterior and loose face.

The cruræus muscle is mostly covered above by the vastus externus and the vastus internus; it is entirely covered below by the rectus muscle, excepting however its outer and lower lateral face, where it is concealed by the vastus internus muscle. Its lower part also is intimately connected with the two vasti, especially the externus.

A capsular ligament exists between its tendon, that of the vastus externus, the capsular ligament and the patella; this frequently opens into the femoro-tibial articulation.

It extends the knee.

§ 1228. The common tendon of these four muscles, after enveloping the patella, goes to attach itself to the tuberosities of the tibia, where we find a considerable synovial capsule between it and the bone.

E. SUBCRURALIS.

§ 1229. The *subcruralis* muscle is a small triangular muscle, which always exists and is entirely covered by the lower part of the preceding. It arises from the lower fourth of the anterior face of the femur, and is attached to the upper part of the anterior wall of the synovial capsule of the knee. It draws this capsule in the motion of extending the leg, and also prevents it from being injured.

III. FLEXORS OF THE LEG.

§ 1230. The flexors of the leg are situated on the posterior face of the thigh. We number three, two internal and an external; but the latter arises by two heads. All arise at the side of each other from the sciatic tuberosity, and are attached posteriorly to the bones of the leg. They consequently bend the knee, or draw the posterior faces of the thigh and of the leg towards each other. They also extend the coxo-femoral articulation when the leg is extended.

I. INTERNAL FLEXORS.

§ 1231. The two inner or tibial flexors arise from the sciatic tuberosity and are inserted in the upper end of the tibia. They are called the *semimembranosus* and the *semitendinosus*.

A. SEMITENDINOSUS.

§ 1232. The *semitendinosus* muscle, *Ischio-pretibial*, Ch. (*M. semi-tendinosus*, s. *seminervosus*), is an elongated muscle broader and thicker above than below, partially covering the following, because it is extended more below it and nearer the surface. It arises from the inner part of the posterior face of the sciatic tuberosity by a tendon which is very distinct outwardly, while its summit adheres very intimately to the inner edge of that of the long head of the biceps femoris muscle. This muscle is the most internal of the three flexors, and goes directly downward. Its lower tendon commences on its inner edge, a little below the centre of the fleshy belly; from about the last fourth of the thigh it forms a very strong rounded cord, which passes behind the inner condyle of the femur to arrive at the tibia, and is attached, after enlarging and becoming thinner, to the inner face, directly below the gracilis muscle. It blends with the lower edge of the tendon of this latter muscle, and generally divides below into an upper and a lower slip.

We find a mucous bursa directly near its insertion, between its upper tendon and that of the semimembranosus and the long head of the biceps. There is also another, and sometimes two or three, even between its lower tendon; that of the sartorius, that of the gracilis, and the internal lateral ligament of the knee.

This muscle bends the leg and turns it a little inward; when it acts in an opposite direction it draws the pelvis and the trunk backward, and bends them with the thigh in the same direction.

B. SEMIMEMBRANOSUS.

§ 1233. The *semimembranosus* muscle, *Ischio-popliti-tibial*, Ch. (*M. semimembranosus*), follows a direction to a certain extent directly opposite to that of the preceding. Of the three flexors this arises farther outward, upward, and outward from the outer part of the sciatic tuberosity by a very long, strong, broad, and perfectly distinct tendon, which gradually enlarges and becomes thinner as it descends to the centre of the thigh and to the end of the fleshy belly, to which it is united by an oblique oblique from within outward. This belly is elongated, rounded, thicker, but shorter than that of the semitendinosus, and is formed of an internal and an external layer of fibres which are turned upward towards each other, and are attached by radiations to the upper tendon. The latter exists only on the outer face of the upper part of the muscle; from its centre to its lower end, where it appears externally as a narrow band, it penetrates deeply inward to the centre of its substance. The lower tendon, which proceeds nearly to the centre of the muscle on its anterior face and on its inner edge, passes on the outer face of the inner condyle of the femur, between it and the semitendinosus

muscle, and is inserted to the inner part of the inner condyle of the tibia, after passing freely a short distance.

A mucous bursa exists between the upper tendon and the quadratus femoris or the adductor magnus. Sometimes there are two. Another is found between the lower tendon, the upper internal head of the gastrocnemius and the capsular ligament of the knee. This bursa often encloses another which is smaller, and adheres very intimately to the tendon of the semimembranosus muscle.

The action of this muscle is the same as that of the preceding.

II. BICEPS FEMORIS.

§ 1234. The *biceps femoris* muscle, *Ischio-femoro-peronier*, Ch. (*M. flexor cruris externus*, s. *fibularis*, s. *biceps femoris*), arises above by two separate heads, which are attached below by a common tendon.

The long head arises from the posterior face of the sciatic tuberosity by a short but firm tendon, which is inserted between the two preceding muscles. A short distance from its upper extremity this tendon begins to receive the fasciculi of the fleshy belly, and descends along its inner edge. The belly descends at first in a straight line, behind and at the side of the upper part of the semimembranosus muscle; but it then goes outward, passes over the adductor magnus, and thus arrives at the outside of the thigh.

The short head is much smaller, and its form is an oblong square. It arises by very short tendinous fibres from the central two fourths of the outer lip of the linea aspera, directly at the side of the adductor magnus, goes obliquely downward, and is attached to the inner face of the lower tendon of the long head, from the lower fourth of the thigh to near its lower end.

The common inferior tendon, which goes nearly to the centre of the large belly, on its posterior face, descends on the outer face of the outer condyle of the femur, and is inserted at the top of the head of the fibula, where there is a mucous bursa between it and the external lateral ligament of the knee.

The biceps femoris muscle bends the knee, turns the leg a little outward, extends the pelvis, and inclines it slightly downward and backward.

§ 1235. Sometimes the short head does not exist, a remarkable analogy with animals, in most of which it is deficient. But in other subjects we find a third, which is thinner, and comes sometimes from the sciatic tuberosity, and is attached below the common tendon of the muscle,* and sometimes arises from the upper part of the long head, descends on the calf of the leg, and is joined by the lower end to the tendo Achillis ;† this deserves to be remarked because the biceps femoris muscle descends very low in the mammalia.

* Gantzer, *loc. cit.*, p. 15.—Sœmmerring, *Muskelehre*, p. 276.
† Kelch, *loc. cit.*, p. 42, No. xxxvi.

When this anomaly exists the biceps femoris resembles the normal structure of the biceps flexor cubiti, even as the latter, when it presents a third supernumerary head, represents the anomaly, of which the other sometimes gives an instance.

ARTICLE FOURTH.

MUSCLES OF THE LEG.

§ 1236. The muscles of the leg occupy its posterior, external and anterior faces; but they leave the internal loose, so that on this side the tibia is covered only by the skin. Most of them are attached, by their upper extremities, to the bones of the leg, and by their lower, to those of the feet as far as the toes. Some, however, come from the lower part of the thigh, their lower extremities are inserted in the bones of the leg.

I. POSTERIOR MUSCLES.

§ 1237. The posterior muscles of the leg form two layers, a superficial and a deep layer.

I. SUPERFICIAL LAYER.

§ 1238. The superficial layer of the posterior muscles of the leg is composed of two muscles, the triceps suræ and the plantaris.

A. TRICEPS SURÆ.

§ 1239. The *triceps suræ* muscle (*M. triceps suræ*, s. *gemelli cum soleo*) is extremely strong, and forms most of the muscular mass of the leg; it deserves to be considered as a separate muscle with three heads, since these heads, although entirely separated above, are all attached below to a common tendon.

Two of these heads are in pairs and the third is single. The first two called for this reason the *gastrocnemii* muscles, *Bi-femoro-calcaiens*, Ch., (*M. gemelli suræ*), are situated at the side of each other. They arise by a short, broad, but thin tendon, which terminates above by a semicircular convex edge from the femur, above the upper edge of the posterior face of its inner and outer condyle.

These two bellies are triangular and much narrower above than below. Above there is an interval of about four inches, which is filled by an abundant and very loose cellular tissue and also by the vessels and the nerves of the leg. Their fibres converge from above downward and meet the common tendon a little above the centre of the whole length of the muscle. The upper tendon, which is expanded along

the external edge and the posterior face, gradually becomes thinner and descends almost to the lower extremity of the fleshy belly. The latter terminates below in a rounded edge; so that the two bellies unite and form a waved line, very concave in its central part. The inner belly is much stronger and descends much lower than the outer. The lower tendon, in which the two fleshy bellies are inserted, arises far above their anterior face, that which corresponds to the posterior face of the bones of the leg, from the union of the two bellies to the centre of their common lower edge: it forms a broad canal, through which pass the branches of the nerves and vessels which descend on the posterior face of the loose portion of the common tendon.

The third belly, called also the *solæus* muscle, *Tibio-calcanien*, Ch., is much stronger than the two preceding. It is situated below and before them.

It arises by its upper edge, which is fleshy, serrated, and oblique downward and inward, from the posterior part of the head of the fibula, from the lower edge of the poplitæus muscle, and from the posterior edge of the tibia. Its lower edge and a part of its anterior face arise for a considerable distance above from the posterior face and below from the inner edge of the tibia. Finally, its outer edge comes from the upper part of the posterior face and from the outer edge of the fibula.

Its posterior and upper fasciculi go directly downward. The anterior and inferior of the two sides meet each other below and are attached to the anterior face of the common tendon, covering its anterior face to some inches above its insertion, gradually becoming thinner and narrower, so that this belly consequently occupies nearly all the leg, and descends very much lower than its centre.

The tendons by which the two lateral edges of this muscle arise from the fibula and the tibia gradually enlarge, descend on the anterior edge and on the posterior face, and do not stop except at some inches above the lower end of this fleshy belly. Hence most of the latter is enclosed between two aponeurotic expansions.

The common inferior tendon, called the *Achilles tendon* (*tendo Achillis*), from its power, is slightly covered above and behind by the two posterior bellies and before by the third belly. A little above the lower edge of the posterior bellies it divides into an anterior and a posterior tendinous layer. The latter reascends on the anterior face of the gastrocnemius in the manner mentioned above: the other covers the posterior face almost to the upper edge, gradually becoming thinner.

The tendon, considered as a whole, contracts very much from above downward, and also becomes thicker, and is attached by a very narrow edge to the upper part of the posterior face of the tubercle of the calcaneum, between which and its anterior face we find a considerable mucous bursa above its insertion.

The triceps extends the foot in raising the heel: hence why it acts principally in standing on the toes and other similar circumstances.

When the foot is fixed, the two upper heads bend the knee and draw the thigh backward and downward. The lower head, when it contracts toward the heel, extends the foot, because it carries the leg downward.

This muscle corresponds to the supinators and to the pronator quadratus of the fore-arm: the two superficial heads represent the supinators and the deep head is analogous to the pronator.

B. PLANTARIS.

§ 1240. The *plantaris* muscle, *Petit femoro-calcanien*, Ch., arises by a short tendon from the posterior face of the external condyle of the femur, from the external head of the gastrocnemius muscle, to which it is united, and from the posterior wall of the synovial capsule. Proceeding directly behind the capsule, it goes inward and downward and even becomes a long, thin, and flat tendon, which descends along the inner edge of the tendo Achillis, unites with it below, and disappears in the cellular tissue on the inner face of the calcaneum to arrive at the tendinous expansion of the sole of the foot.

This muscle has no very manifest action. We see in it only a rudiment of that which is much more developed in some mammalia and an imperfect imitation of the palmaris brevis of the hand.

§ 1241. It is often deficient and much more frequently than the palmaris.*

II. DEEP LAYER.

§ 1242. The deep layer of the posterior muscles of the leg is composed of the poplitæus, the tibialis posticus, the flexor longus digitorum communis, and the flexor longus pollicis proprius.

A. POPLITÆUS.

§ 1243. The *poplitæus* muscle, *Femoro-popliti-tibial*, Ch., (*M. popliteus*, s. *sub-poplitæus*), is a triangular muscle, which arises from the inferior and posterior part of the outer face of the external condyle of the femur. It is formed of oblique fibres, becomes broader from without inward, and is attached to the upper part of the posterior face of the tibia. It is intimately connected, especially at its upper and outer part, with the posterior wall of the synovial capsule of the knee. We find a mucous bursa between it and the external condyle of the femur on one side, the external semilunar cartilage and the capsular ligament on the other.

* Our observations authorize us to assert that Gantzer mistakes in stating that the plantaris is more constant than the palmaris (*loc. cit.*, p. 4).

This muscle corresponds to the pronator teres of the fore-arm.

It turns the leg a little inward, draws the outer semilunar cartilage outward and backward, and contributes to bend the knee.

§ 1244. Sometimes it is double.*

B. TIBIALIS POSTICUS.

§ 1245. The *tibialis posticus* muscle, *Tibio-sous-tarsien*, Ch., (*M. tibialis*, s. *tibiæus posticus*, s. *nauticus*), arises between the extensor digitorum communis longus and the flexor longus pollicis pedis (§ 1248). It is the longest of the three muscles of the deep-seated layer and is penniform. It arises in its whole length from most of the posterior face of the interosseous ligament and from the inner face of the fibula; some fibres of its upper part arise also from the outer part of the posterior face of the tibia.

Even as in the two long flexors of the toes, the two layers of fibres are attached to a very strong tendon, which descends inward and forward, is contained within the posterior and fibro-cartilaginous groove of the internal malleolus, thence passes into an analogous groove hollowed along the upper part of the inner face of the astragalus, and thus goes to the inner and lower face of the sole of the foot, opposite the anterior part of the inner face of the astragalus. Its tendon encloses a rounded sesamoid bone and divides into two slips: the internal is shorter, the inferior is longer.

The first is single and is attached to the inner edge of the scaphoid bone. The second divides into several bands, which are inserted in the lower face of the scaphoid, the cuboid, and the three cuneiform bones, at the same time that they blend with the aponeurotic expansion of the sole of the foot and with the tendon of the peroneus longus.

The tendon of this muscle is surrounded with a mucous sheath where it arrives at the sole of the foot.

This muscle corresponds to the radialis internus muscle (§ 1149).

It extends the foot, turns its inner edge a little upward, and the sole inward; it also extends the thigh and draws it backward.

C. FLEXOR LONGUS DIGITORUM COMMUNIS.

§ 1246. The *flexor longus digitorum communis* muscle, *Tibio-phalangettien*, Ch., (*M. flexor digitorum communis longus*, s. *perforans*, s. *profundus*), is a thin, elongated, and penniform muscle; it arises from the summit of the anterior face of the tibia, except its upper part, which is covered by the poplitæus. The fasciculi, by which it arises, and which converge downward, are inserted in a strong tendon below, which ascends almost to the upper extremity of the muscle and proceeds along the inner edge. This tendon approaches the surface, descends on the

* Fabricius, *De motu locali animalium*, in *Op.*, p. 359.

oster or face of the tibia, goes to the inner face of the tarsus, and nters a fibro-cartilaginous furrow which exists along the upper part f the inner face of the astragalus, and is there kept in its position by tendinous sheath, and thus goes forward. After leaving this point turns outward, is covered by the posterior head of the abductor ollicis pedis muscle, on which it continues to go forward, and soon ivides into four bands, which go in their turn on the flexor digitorum revis, which is consequently covered by it.

At the place where the tendon of the flexor longus muscle passes on ie flexor brevis and before it divides into four bands, we see a small nuscle attachedto its external and inferior part. The form of this nuscle is an oblong square. It may be called the *small* or *accessory ead* of the flexor longus communis (*accessorius perforantis*).

This small head, which is covered on all sides by the flexor commus digitorum brevis, arises by two slips, the posterior or external, which longer and stronger and comes from the external anterior tuberosity the calcaneum, and the anterior or internal, which is smaller and ises from the superficial calcaneo-cuboid ligament (§ 982). Its fibres e oblique. It goes forward and inward, and not only is it fitted by s inner edge to the tendon of the flexor digitorum longus, but contri- ites much by its anterior tendons to form those of this muscle.

The small head principally forms almost the whole tendon of the cond toe. Most usually this tendon is not at all derived from that the slip of the common flexor, but only from the short head and from e tendon of the extensor longus proprius pollicis, with which the ntre of the flexor communis communicates near the anterior xtremity of the calcaneum.

The tendons of this muscle have the same relation to those of the ort flexor as those of the flexor digitorum sublimis have with those the flexor profundus. They are situated upon them, perforate them ove the second phalanx of the toes, enlarge a little, and are attached the posterior part of the lower face of the third phalanges.

It is surrounded by a mucous sheath in the place where its tendon sses at the side of the fibula and of the calcaneum. A second enve- os this tendon and that of the flexor longus pollicis proprius at the sterior extremity of the sole of the foot.

The tendon it gives to each toe and that of the flexor minimi digiti oprius are surrounded with a proper mucous sheath.

This muscle bends the third phalanx of the toes and brings the leg ckward.

§ 1247. Sometimes it is furnished with a fifth tendon, which replaces fourth of the flexor digitorum brevis, which is then deficient. This ndon proceeds along the inner edge of the fourth tendon of the flexor gus, and divides to allow the latter to pass, and consequently pre- its the same arrangement as the flexor sublimis.* This formation

* Brugnone, *loc. cit.*, p. 176.

evidently resembles that of the apes, in which the tendons of the flexor sublimis and flexor profundus are so blended that they are distinguished from each other with difficulty.

D. FLEXOR LONGUS POLLICIS PROPRIUS.

§ 1248. The *flexor longus pollicis proprius* muscle, *Peronco-sous-phalangettien du pouce*, Ch. (*M. flexor hallucis longus*), is shorter but much stronger than the preceding. It arises by an internal and an external layer of fibres, which converge downward and proceed by fleshy fibres from almost all the lower half of the posterior face and from the outer edge of the fibula, excepting only its lowest portion. These two orders of fibres are inserted in a strong lower tendon, which mostly remains concealed in the midst of the muscular substance and becomes entirely loose only when its fleshy fibres cease. This tendon goes obliquely from without inward and from behind forward, and thus comes on the inside of the tarsus, whence it goes forward along a fibro-cartilaginous groove, which exists at the upper part of the inner face of the calcaneum, directly below the upper edge of this bone, and where it is retained by a special sheath. It is covered by the outer slip of the posterior head of the abductor pollicis pedis muscle and directly by the tendon of the flexor communis digitorum longus which is nearer the surface, and is consequently situated beneath it. It crosses the direction of the latter and sends to it a very strong tendon, which unites principally to that of the second toe.

We may justly say that the tendon of the flexor longus pollicis proprius muscle divides into two slips where it passes under the abductor pollicis pedis, an external for the second toe and an internal for the large toe. The latter is the strongest; it goes inward and forward directly at the side of the abductor pollicis pedis, is situated outward before it, and is partly covered by it. At the anterior end of the metatarsal bone of the large toe it enlarges a little, at the same time becomes thinner, and is attached to the posterior part of the lower face of the second phalanx of the large toe.

This muscle corresponds to the flexor longus digitorum communis in its course and in its attachment to the anterior phalanx of its toe.

There is in fact a short flexor of the large toe; but this muscle has no perforated tendon which is attached to the posterior phalanx. On the contrary, we sometimes see an arrangement analogous to that of the tendons of the flexor brevis perforatus. In fact a strong but narrower tendon, which however gradually enlarges as it advances, extends from the head of the first metatarsal bone to the posterior end of the second phalanx, over the tendon of the flexor longus: this tendon isfirmly attached in its whole extent and breadth of its upper face to the lower face of the phalanges, by a fold of the synovial capsule: it contains a single and transverse sesamoid bone: immediately behind its anterior extremity and below the articulation of the first phalanx

with the second, it is finally attached to the lower face of the first phalanx, directly behind the tendon of the flexor longus.

This tendon which has no muscle, is not found in the other toes; so that decidedly we should consider it as a rudiment of the flexor longus communis perforatus: it is however but an imperfect rudiment, since it is never perforated, which depends probably on the absence of the second phalanx of the large toe.

The tendon of this muscle is enveloped with a mucous bursa in the canal of the astragalus and os calcis. A second covers its tendon and that of the flexor longus at the posterior part of the sole of the foot. A third incloses its tendon along the metatarsal bone of the first toe.

It flexes the large and small toe.

§ 1249. We sometimes find at the lower part of the posterior face of the leg a small supernumerary muscle, which does not always present exactly the same arrangement. Sometimes it ascends from the calcaneum and from the tendo Achillis, and is attached to the aponeurotic expansion of the leg, acting as its tensor muscle;* so that we may then consider it as a fourth head of the triceps. It sometimes arises from the lower part of the fibula, goes downward, and is then lost around the articulation of the foot. It is sometimes attached to a special bone found in this place,† or to the lower face of the calcaneum, or finally to the small head of the flexor longus digitorum communis.‡

The second anomaly is very probably a repetition of the pronator quadratus of the upper extremity, but it is developed lower toward the foot, in accordance with the same law as that to which the other muscles are subjected, especially the flexors and extensors of the toes.

The first corresponds probably to the palmaris brevis; the arrangement of the muscle in the upper and lower extremity differs in the same way as the palmaris brevis and the plantaris, as the latter does not arrive at the aponeurotic expansion of the sole of the foot.

II. EXTERNAL MUSCLES.

§ 1250. The external muscles of the leg are the peroneus longus and the peroneus brevis. They extend from the fibula to the outer edge and to the lower face of the foot.

I. PERONEUS LONGUS.

§ 1251. The *peroneus longus* muscle, *Peroneo-sous-tarsien*, Ch. (*M. peroneus longus*, s. *primus*, s. *posticus*), arises from the upper and smaller half of the anterior face, and by fibres which proceed obliquely from above downward and converge. Its upper tendon arises from the outer edge of the fibula and covers the upper and posterior part of this bone.

* Mayer in Heymann, *loc. cit.*, p. 15.
† Rosenmüller, *loc. cit.*, p. 8.
‡ Gantzer, *loc. cit.*, p. 15-17.

The lower tendon, which is very long, very strong, flat, and entirely loose from the lower third of the leg, conceals itself partially above this point between the muscular fibres; so that it entirely disappears externally toward the bottom of the upper third of the leg. But it appears again within the muscle, near its upper extremity, as a semicircular band, which gradually diminishes and to which the fleshy fasciculi are attached outward and inward.

This tendon goes behind and on the outside of that of the peroneus brevis, along the outer and posterior face of the leg, and descends behind the external malleolus across a ligament formed of oblique fibres, within which is a sheath which sends prolongations to it. Arrived at the foot, the tendon winds forward and downward, around the outer edge of the cuboid bone, and thus comes on the sole of the foot, where it penetrates; thence it goes inward, covered by all the muscles of this region and directly by the calcaneo-cuboid ligament, which keeps it in place: then gradually enlarging, it is attached to the lower face of the cuboid bone and also to the lower face of the posterior head of the fifth, also of the fourth and third, and particularly of the second metatarsal bones: it sometimes also reaches the first metatarsal bone and the first cuneiform bone before dividing.

At the place where the friction of the tendon is the greatest, especially opposite the external malleolus, the tuberosity of the calcaneum, and the cuboid bone, sometimes also in its plantar portion, we find sesamoid bones or cartilages, the third of which is the largest, while the first is very small and often scarcely perceptible.

There is also a considerable mucous bursa where the tendon of the muscle descends on the outer malleolus and astragalus: this bursa envelops it and also the tendon of the following muscle. We find another below, which extends to the plantar face.

The peroneus longus muscle extends the tibio-tarsal articulation and draws the foot backward and the leg downward: it also turns the foot, making its outer edge the upper and the plantar face look upward.

It corresponds to the flexor carpi ulnaris of the fore-arm.

II. PERONEUS BREVIS.

§ 1252. The *peroneus brevis* muscle, *Grand peroneo-sus-metatarsien*, Ch. (*M. peroneus*, s. *fibularis brevis*, s. *anticus*, s. *secundus*, s. *medius*, s. *semifibulæus*), is an elongated muscle, which terminates above in a point and is formed of two layers of fibres; those of the anterior layer go from before backward and those of the posterior go from behind forward. These two layers converge toward the base: they arise from the second fourth of the anterior face and from the posterior edge of the fibula to near the outer malleolus.

The lower tendon, which is long, strong, and flat, extends within the muscle, and like that of the preceding ascends almost to its upper extremity. It becomes visible externally sooner than that of the

peroneus longus, and descends between the fibres of the muscle to arrive at its outer face.

Once disengaged it goes before that of the peroneus longus, behind the outer malleolus, and is retained in the groove which exists there by a ligament, common to it and the preceding muscle. This ligament, called the *retinaculum musculorum peronæorum*, extends from the anterior to the posterior edge of the groove like a bridge. The tendon having thus reached the upper face of the foot goes forward, enlarging along its anterior edge. Near the base of the fifth metatarsal bone it usually divides into two slips, the outer of which is attached to the tuberosity of this bone while the inner is longer, subdivided likewise into two parts, one of which is attached to the centre of the upper face of its body; the second is inserted partly in the outer edge of the fourth tendon of the extensor and partly on the posterior face of the fourth external interosseous muscle.

Besides the common mucous bursa (§ 1229) the tendon of this muscle has a special bursa situated lower on the outer edge of the foot, and which surrounds it.

The peroneus brevis muscle acts like the preceding; it flexes the tibio-tarsal articulation, consequently carries the foot upward, and depresses the leg; it also turns the sole of the foot outward and its outer edge upward, but less so than the peroneus longus.

It corresponds to the extensor carpi ulnaris, and partially also to the extensor brevis minimi digiti.

§ 1253. It is sometimes double.

III. ANTERIOR MUSCLES.

§ 1254. On the anterior face of the leg we find one after another the extensor longus digitorum communis, the extensor longus hallucis proprius, and the tibialis anticus.

I. EXTENSOR LONGUS DIGITORUM COMMUNIS.

§ 1255. The *extensor longus digitorum communis* muscle, *Peroneo-us-phalangettien commun*, Ch. (*M. extensor digitorum communis longus*), is a very long muscle, occupying almost all the leg. Its fibres ascend obliquely from behind forward. It arises above from the outer face of the head of the tibia, and, in the rest of its course, from the anterior face of the interosseous ligament, and also from the anterior edge of the fibula. It is attached to the tendon which commences near its upper extremity and which descends on its anterior edge.

This tendon generally divides below the crucial ligament of the foot into five slips, which separate from each other. The outer is the shortest, and is inserted into the posterior extremity of the upper face of the fifth, and sometimes also of the fourth, metatarsal bone. This slip is sometimes connected with a special fleshy belly entirely distinct

from the extensor longus, but which most generally forms only the lower part, and which is called the *small* or *the peroneus tertius* muscle. It is not unfrequently deficient, and is then replaced to a certain extent by the inner part of the tendon of the peroneus brevis muscle: it also frequently forms a small special tendon which is sometimes attached forward to the metatarsal bone, and sometimes unites either to the fourth external interosseous muscle or to the tendon sent by the common extensor to the fifth toe. The four other slips go obliquely forward and outward; they are attached to the dorsal faces of the second, third, fourth, and fifth toes. Arrived at the base of the posterior phalanges they become broader and a little thinner, and give off also, the fourth outwardly, the other three inwardly, a thin triangular prolongation, formed of perpendicular fibres, which go downward, and are attached partly to the base of the first phalanx, and are partly blended with the tendon of the interosseous muscles.

This tendon sometimes assumes the nature of cartilage when passing over the synovial capsule of the first phalangean articulation. On the articulation between the second and third it enlarges or divides more or less completely into two lateral slips, which converge forward, and after uniting are attached to the upper face of the third phalanx, directly before its posterior edge.

We find an oblong mucous bursa on the articulation of the foot, between the tendon of this muscle and the capsular ligament.

The extensor digitorum communis longus raises the four smaller toes, extends them, and with the peroneus brevis muscle, bends the tibio-tarsal joint, and thus raises the foot or draws the leg forward and downward.

This muscle and the preceding act principally in standing on the toes, because they fix the leg.

The extensor digitorum communis longus corresponds to the common extensor of the fingers. The proper extensor of the little finger is represented by the peroneus tertius, and when that is deficient by a part of the peroneus brevis.

This analogy becomes still more evident when the portion of the flexor longus belonging to the little toe, and the peroneus tertius muscle, are entirely separated from the rest of the muscle.*

II. EXTENSOR LONGUS HALLUCIS PROPRIUS.

§ 1256. The *extensor longus hallucis proprius* muscle, *Peroneo-sus-phalangettien du pouce*, Ch., is a thin and semipenniform muscle, which arises, by fleshy fibres, from the lower two thirds of the inner face of the fibula, and from the anterior face of the interosseus ligament. It also receives below some fibres from the outer face of the tibia.

Its fasciculi are attached to a tendon which proceeds along the anterior edge of the muscle, gradually becomes broader, passes across

* Brugnone, *loc. cit.*—We have seen it several times.

a particular groove of the crucial ligament of the back of the foot, goes inward and forward along the inner edge of the tarsus, and is attached to the upper face of the unguæal phalanx of the first toe.

On the back of the tibio-tarsal articulation the tendon of this muscle is inclosed in a special mucous sheath.

It raises all the first toe.

§ 1267. This muscle is often more or less completely double. In this case we sometimes find another which is smaller and which arises more externally from the fibula, and from the anterior face of the interosseous ligament, goes to the large toe, and unites to the tendon of this muscle, or is attached to the first metatarsal bone, or finally loses itself in the cellular tissue. Sometimes and most generally another smaller tendon is detached, even in the leg, from the inner edge of the normal tendon, which is inserted in the tibial side of the two phalanges. These anomalies are important because they approximate the formation of the proper extensor of the large toe to that of the proper extensor of the thumb; so too on the other hand, the deficiency of the short extensor of the thumb, or its blending with the large, approximates the formation of the hand to that of the foot.

III. TIBIALIS ANTICUS.

§ 1258. The *tibialis anticus* muscle, *Tibio-sus-tarsien*, Ch. (*M. tibialis*, s. *tibiæus anticus*, s. *catenæ musculus*, s. *hippicus*), is the strongest of the three anterior muscles of the leg; it arises directly at the side of the peroneus longus muscle, and is covered in this place by a broad tendon, which expands on its anterior face from the lower face of the outer part of the head of the tibia, and still lower from the outer face of this bone, nearly to its lower third, so that its fibres gradually come nearly from the most posterior portion, and even the inner edge of this face in all its course. At the same time it receives some which arise from the periosteum. All these fibres, which go obliquely forward, are attached to an anterior tendon, which is loose only in a very small point of its extent downward, but which extend within the muscle even beyond its centre. This tendon, which is very strong, descends obliquely inward, passes on the anterior face of the tibio-tarsal articulation, comes upon the inner edge of the foot, where it is retained by a ligamentous band, oblique downward and backward, which extends from the scaphoid to the first cuneiform bone, and is finally attached by two short slips to the inner part of the lower face of the large cuneiform bone, and also to the base of the metatarsal bone of the large toe.

Opposite the articulation of the foot its tendon is enveloped in a mucous sheath.

It raises the foot, turns it on its axis, so that its sole looks inward and its inner edge upward.

It corresponds to the radiales muscles of the hand.

ARTICLE FIFTH.

MUSCLES OF THE FOOT.

§ 1259. The muscles of the foot arise from the tarsus and metatarsus, and are all attached to the phalanges of the toes. They are situated on the back of the foot, on its sole, on its internal and external edges. Some are common to several toes, others belong exclusively to some of them, namely to the large and small toes. The latter are only repetitions of those which are divided between several of them.

I. MUSCLES OF THE BACK OF THE FOOT.

§ 1260. Besides the tendons of the extensor digitorum communis longus and of the two peronei muscles, we find also on the back of the foot the extensor communis digitorum brevis.

EXTENSOR COMMUNIS DIGITORUM BREVIS.

§ 1261. The *extensor communis digitorum brevis* muscle, *Calcaneo-sus-phalangettien commun*, Ch., (*M. extensor digitorum pedis communis brevis*, s. *pediæus externus*), is a flat muscle, formed of four elongated and rounded bellies, which arises from the back of the anterior process of the calcaneum, goes forward and inward, its bellies separating from each other, and is attached by four tendons to the four inner toes. These tendons in their course on the metatarsus cross those of the extensor communis digitorum longus, but on the toes they are situated on the outside of them. The outer three are very intimately blended, by their internal edge, with the outer edge of the tendons of the extensor longus, and consequently form their outer half; but the most internal, that which goes to the great toe, does notunite to the corresponding tendon of the flexor longus, but is attached below it to the posterior edge of the back of the first phalanx of the great toe.

This muscle extends the four inner toes and directs them a little outward.

§ 1262. Often and even most generally its inner belly is separated much more from the others than the latter are from each other. Very frequently it forms an entirely distinct muscle, which deserves to be noted because of the more striking resemblance established between the upper and lower extremities by this peculiarity. Sometimes the other bellies and even all are entirely detached from each other, a curious analogy with what exists in birds. Again, the extensor brevis often presents supernumerary bellies. Most commonly a small fleshy fasciculus exists between the internal and what is commonly called the second; its tendon is attached either to the second metatarsal bone or to the tibial face of the second toe. This accessory muscle mentioned

by Albinus,* and which we have often seen, is curious, as it must evidently be considered as a repetition of the indicator muscle.

The second belly is also sometimes divided at its anterior extremity into two fasciculi, or sends two tendons to the second toe.

The tendons of the third and fourth bellies are often divided, so that there is for the third toe an extensor muscle or at least a tendon ; this arrangement resembles the doubling of the proper extensor of the index finger in the hand for a proper extensor of the third finger.

After this anomaly the one most frequently found consists in the presence of a small special belly for the fifth toe. We have also seen this several times, and it is interesting as an analogy either with the apes† or with the extensor proprius minimi digiti.

II. MUSCLES OF THE SOLE OR THE FOOT.

§ 1263. Most of the muscles of this part of the lower extremity are found in the sole of the foot.‡ In fact, besides the short head of the extensor digitorum communis already described (§ 1245), we find the flexor communis digitorum brevis, the adductor and flexor of the large and little toes, the adductor hallucis, the lumbricales, and the interossei muscles.

The adductor hallucis occupies the inner edge of the foot and that of the little toe the outer edge. A great part however of these muscles project likewise in the sole, so that it is best to study them at the same time as the other muscles of the toes, to which they belong, and to consider them as the lower muscles of the foot.

We shall describe first the common muscles, next the special muscles : first, however, their common aponeurosis.

I. PLANTAR APONEUROSIS.

§ 1264. The *plantar* (*aponeurosis aponeurosis plantaris*) is a very firm tendinous layer, formed of longitudinal fibres, which arises from the lower face of the tuberosity of the calcaneum, directly under the skin, with which it is intimately connected. Thence it goes forward, where it enlarges very much. Arrived at the anterior edge of the metatarsus it divides into five slips, which correspond to the five toes, and which are attached to each other by transverse fibres.

This aponeurosis protects and fixes the muscles of the sole of the foot, and at the same time increases the surfaces of insertion of several.

* *Hist. musc.*, p. 602.

† Meckel, *Beytröge zur vergleichenden Anatomie*, vol. ii. part i.

‡ A. P. Walther, *Tractationes de articulis, ligamentis et musculis incessu dirigendis supplementum tabulamque novam plantæ humani pedis exhibens*, Leipsic, 31. — D. C. de Courcelles, *Icones musculorum plantæ pedis, eorumque descriptio*, sterdam, 1769.

II. COMMON MUSCLES OF THE SOLE OF THE FOOT.

a. Flexor digitorum pedis communis brevis.

§ 1265. The *flexor communis digitorum brevis* muscle, *Calcaneo sous-phalanginien commun*, Ch., (*M. flexor digitorum pedis communis brevis*, s. *perforatus*, s. *sublimis*, s. *pediæus internus*), is elongated, quadrilateral, thicker behind, and broader but thinner before. It arises by very strong tendinous fibres, which extend on a considerable portion of its lower face from the lower face of the tuberosity of the calcaneum, and by fleshy fibres by almost all its lower face, from the upper face of the plantar aponeurosis, to which its posterior tendon also adheres. Posteriorly it is very intimately united internally with the outer edge of the adductor pollicis, and above with the short head of the extensor communis digitorum longus. Nearly in the centre of the sole of the foot it divides into four very short fleshy fasciculi, which soon become as many single tendons. The latter are attached to the second, third, fourth, and fifth toes. They cover those of the extensor longus and are much smaller. They are arranged in the same manner anteriorly as those of the extensor digitorum sublimis. In fact a rhomboidal fissure begins a little before the posterior extremity of the first phalanx, which extends to before the centre of this bone. The tendons of the extensor communis digitorum profundus pass through these fissures.

The two halves of the tendon which pass through this division unite for a short extent; then again separate, enlarge and diverge from before backward, and are separately attached by straight edges to the centre of the lower face of the second phalanx.

Each tendon of this muscle is attached with the corresponding tendon of the flexor longus, to the lower face of the toes, by synovial and fibrous ligaments, exactly like those which retain the tendons of the flexor sublimis and profundus of the fingers.

This muscle flexes the first and second phalanges of the four outer toes.

§ 1266. The fourth tendon is sometimes deficient, and then it is often but not always replaced by a tendon of the flexor longus. In some subjects there seems to be an antagonism between the short extensor and the short flexor of the toes; for we have sometimes found in this case the number of tendons of the second is greater than usual.

Sometimes also another portion of the muscle is deficient; it is usually the most internal or the most external. It is then replaced by other fasciculi which come from the flexor of the large and that of the little toe, which reminds us of the insulation of the internal head of this muscle in apes, and the disappearance of the short common flexor as a separate muscle in all the other mammalia and in all birds.

b. Lumbricales.

§ 1267. The *lumbricales* muscles, *Planti-sous-phalangiens*, Ch., correspond to those of the hand in number, form, and situation. They arise by fleshy fibres from the tendons of the flexor digitorum longus, and are attached, partly by short tendons, to the posterior head of the first phalanx of the four outer toes, and partly by thin tendinous expansions, to the tendons of the extensor digitorum longus.

c. Interossei.

§ 1268. We find in the foot as in the hand seven *interossei* muscles, *Metatarso-phalangiens lateraux*, Ch. (*M. interossei*), which fill the intervals between the metatarsal bones. They arise from the posterior part and from the lateral faces of these bones, and their anterior tendons blend below with those of the extensor communis.

We distinguish them into *external* and *internal*. The first are four and the second three in number.

a. External interossei.

§ 1269. The *upper* and *external* or *dorsal interossei* muscles, (*M. interossei externi*, s. *superiores*, s. *dorsales*) are situated directly below the extensor communis digitorum brevis, in the first, second, third, and fourth interosseous spaces.

The first, which is the most internal, differs from the other three in its form and arrangement. In fact it comes only from the tibial side of the second metatarsal bone and is attached forward by a short, broad, and flat tendon to the inside of the first phalanx of the second toe.

It is however almost always divided into two heads, the upper of which is longer and much thinner than the lower.

The second, third, and fourth have two heads each, which are inserted by short tendons on the outer or fibular side of the first phalanx of the second, third, and fourth toes.

The outer head is much larger, arises from the posterior part of the inner face of the metatarsal bone, which is placed directly on the outside of the toe to which the tendon is attached, and descends as deeply as the internal, on the side of the sole of the foot. The inner is the smallest, and arises from the posterior part of the outer face of the metatarsal bone of the toe in which its tendon is inserted, and descends a little lower than the preceding. The fibres of these two heads unite at a very acute angle and are implanted in a common tendon.

The first external interosseous muscle brings the first toe inward; the second, third, and fourth carry the toes to which they are attached outward.

b. Internal interossei.

§ 1270. The *internal, inferior*, or *plantar interossei* muscles (*M. interossei interni*, s. *inferiores*, s. *plantares*) are smaller than the external and have only one head. They arise from almost all the posterior part of the inner or tibial face of the third, fourth, and fifth metatarsal bones, and are attached by a considerable tendon to the inner face of the first phalanx of the third, fourth, and fifth toes. This tendon is closely united to the capsule of the metatarso-phalangean articulation, and sends a prolongation to that of the extensor communis.

These muscles direct the third, fourth, and fifth toes inward toward the large toe.

III. PROPER MUSCLES OF THE TOES.

§ 1271. We may consider as proper muscles those of the large and small toes.

a. Muscles of the large toes.

a. Abductor hallucis.

§ 1272. The *abductor hallucis* muscle, *Metatarso-sous-phalangien du premier orteil*, Ch., is the strongest short muscle of this toe. It arises by several slips from the inside of the tarsus and the metatarsus, and is attached to the inside of the large toe. To simplify the description, we may refer these several slips to two heads.

The *posterior* head, which is the larger, arises by two bands, of which the inferior is longer, from the lower part of the inner side of the tuberosity of the calcaneum, and the upper, which is shorter, from the upper and projecting part of the inner face of the body of the calcaneum.

The *anterior* head, which is the smaller, arises by three or four distinct slips from the inner and anterior face of the astragalus, scaphoid, the first cuneiform, and first metatarsal bone. The posterior tendon of these two fasciculi covers them from their origin to near their anterior extremity below. The anterior, which is much stronger, begins near the centre of the posterior belly and is situated on its inner side; so that the fibres of the two bellies which go forward and inward arei nserted at acute angles.

This last tendon, after it disappears from the surface, extends very far within the muscle, whence it goes backward and divides into several very considerable slips. Anteriorly, it is sometimes attached by two slips to the lower and inner face of the head of the first metatarsal bone, to the inner face of the capsular ligament of the first metatarso-phalangean articulation, and principally to the inner and lower part

of the base of the first phalanx of the large toe, where it adheres intimately to the flexor digitorum brevis.

This muscle brings the large toe inward and flexes it a little.

b. Flexor brevis pollicis pedis.

§ 1273. The *flexor brevis pollicis pedis, Tarso-sous-phalangien du premier orteil*, Ch. (*M. flexor hallucis proprius brevis*), is much shorter than the abductor. It arises behind from the tendinous sheath of the peroneus longus, intimately united to the long head of the adductor of the large toe. Most generally its posterior extremity may be divided into an external and internal belly. Thence it goes inward and forward. It is attached by a short tendon, more or less divided, to the posterior part of the lower side of the base of the first phalanx of the large toe. This tendon is generally united to that of the adductor outward; it contains anteriorly, below the two parts of the head of the first metatarsal bone, two sesamoid bones placed one at the side of the other.

This muscle flexes the first phalanx of the large toe.

c. Adductor pollicis pedis.

§ 1274. The *adductor pollicis pedis* muscle, *Calcaneo-sous-phalangien du premier orteil*, Ch. (*M. adductor hallucis*), is a considerable muscle which has two bellies.

The *posterior* is much stronger than the other and is placed above and outside of the flexor brevis pollicis pedis. It arises from the lower side of the base of the third and fourth and also often of the second metatarsal bone, and from the sheath of the peroneous longus, above the flexor brevis pollicis pedis. Before, on its outer and lower face, are strong tendinous expansions, which unite to give rise to the anterior tendon. This latter is united to the external tendon of the flexor brevis (§ 1212), and is attached to the outer face of the base of the metatarsal bone.

The anterior head is much smaller and weaker than the posterior, and arises from the lower and inner face of the capsular ligament, between the metatarsal bone and the first phalanx of the fourth and fifth toes, sometimes also from the anterior part of the fifth metatarsal bone.

It goes obliquely forward and inward, directly below the anterior head of the interossei muscles, between these and the tendons of the flexor communis digitorum profundus. It is attached by a thin and short tendon to that of the abductor of the great toe.

b. Muscles of the little toe.

a. Abductor minimi digiti.

§ 1275. The *abductor minimi digiti* muscle, *Calcaneo-sous-phalangien du petit orteil*, Ch. (*M. abductor digiti quinti*), is the longer of the two muscles of this appendage, has two bellies like the abductor pollicis pedis; the posterior belly is greater.

The posterior belly is covered below and behind by a strong aponeurosis, and arises from the posterior and from a little of the anterior part of the lower face of the tuberosity of the calcaneum.

The *anterior* belly comes from the lower edge of the tuberosity of the fifth toe.

Both are attached outwardly to a broad and strong tendon, which extends far back into the substance of the muscle and which is attached to the outer part of the lower face of the base of the first phalanx.

b. Flexor minimi digiti brevis.

§ 1276. The *flexor minimi digiti brevis* muscle, *Tarso-sous-phalangien du petit orteil*, Ch. (*M. flexor digiti quinti proprius brevis*), is much smaller than the preceding. It arises from the inner part of the lower side of the base of the fifth metatarsal bone and from all the lower face of its body. It may almost always be divided into an outer and inner belly. Most frequently also it is attached by two distinct tendons to the inner part of the lower side of the base of the first phalanx.

§ 1277. The muscles of the large and the small toes may be referred to the other muscles of the foot, as we have seen those of the thumb and little finger could be to the other muscles of the hand. The abductor pollicis pedis is the first external interosseous muscle, and the posterior belly of the abductor the first internal interosseous muscle. The anterior belly of the latter represents the first lumbricalis. The flexor brevis digitorum pedis muscle corresponds to the flexor digitorum communis. The abductor minimi digiti is the last external interosseous muscle. Finally, the flexor minimi digiti brevis may be considered as belonging to the flexor digitorum communis, because of the slight development of the fourth tendon of the latter in most subjects.

COMPARISON OF THE MUSCLES OF THE DIFFERENT REGIONS OF THE BODY.

§ 1278. We have already compared the muscles of the different regions of the body with each other in different directions, while describing each one particularly. They also conform to the law that the analogy between the upper and lower halves of the body is more marked than that between the anterior and posterior. In fact we observe, 1st, that many muscles which succeed from above downward

are repetitions of one another, as is evident with those between the vertebræ or between these bones and the head; 2d, the muscles of the limbs correspond very evidently, and the differences they present, like those between the bones and the ligaments, depend on the greater solidity of the lower limbs and the greater mobility of the upper, either when considered as a whole and in their relations with the trunk, or when viewed in detail and in regard to the relations of their different parts with each other. An abnormal arrangement of the muscles belonging to the two extremities frequently renders their similitude more perfect and more evident than it is generally; and if we do not err, of all the organic systems, the muscular most frequently presents anomalies in the configuration, which cause an unusual similitude between the anterior and posterior faces of the body and also between its upper and lower portions.

In this respect we often find an anterior sternal muscle, which determines a resemblance between man and animals, and the existence of which is so curious in another respect; and we not unfrequently find a short head of the biceps flexor cubiti and a short extensor of the middle finger.

So too the muscles of the lower limbs are frequently repetitions of those of the upper. The latter however seem to us more disposed to present assimilating anomalies in their configuration, which probably depends on a general law, amply supported by the vascular system, viz. that anomalies in the pelvic members are more frequent than in the pectoral extremities.

GENERAL REMARKS ON THE MOTIONS OF THE HUMAN BODY.

§ 1279. Having described successively the different organs of locomotion, we must now briefly examine the principal motions* which result from their joint action.

We must first endeavour to prove *that the erect posture on the lower limbs is natural to man.*

A. ERECT POSTURE.

I. OSSEOUS SYSTEM.

§ 1280. We may also point out in this place the conditions which arise from the other organic systems, not yet described, and which refer to the general form of the body, because the osseous system serves as the basis for all the others.

In considering the body from below upward, we discover successively in the osseous system all the conditions which render the erect posture natural to man.

* F. Roulin, *Recherches théoriques et expérimentales sur le mécanisme des mouvements et des attitudes dans l'homme*; in the *Journ. de physiol. exp.*, vol. i. 209, 301, vol. ii. p. 45, 156, 283.

1. In the lower extremities.

§ 1281. 1st. The predominance of the bones of the lower over those of the upper extremities.

2d. It is only in the erect posture that the articular surfaces of all the bones are exactly fitted to each other.

3d. The breadth of the foot.

4th. The size of the tarsus and metatarsus in proportion to the toes.

5th. The number and size of the sesamoid bones.

6th, The union of the bones of the leg with the tarsus at a right angle.

7th. The length and obliquity of the neck of the femur.

8th. The breadth, concavity, and lowness of the iliac bones.

2. In the trunk.

§ 1282. 1st. The lowness, breadth, and curve of the sacrum, and also the curving inward of the coccyx, upon which and also on the arrangement of the iliac bones the peculiar shape of the human pelvis depends, and which seems well adapted only for the erect posture.

2d. The breadth and lowness of the vertebræ.

3d. The considerable curve of the ribs, whence results the breadth and convexity of the thorax.

3. In the head.

§ 1283. 1st. The anterior, posterior, and horizontal position of the condyles and foramen magnum of the os occipitis.

2d. The direction of the cavities of the orbits and nose forward in the erect posture and downward in that on the four limbs.

4. In the upper limbs.

§ 1284. 1st. The shortness and feebleness of these members in proportion to the lower.

2d. The forced position of the bones of the fore-arm and of the radio-carpal articulation in walking on all fours.

3d. The mobility of the radius.

4th. The concavity and breadth of the bones of the metacarpus and of the phalanges. These latter circumstances indicate that the bones of the upper extremities are intended to grasp external objects, while the corresponding parts of the lower limbs prove they are designed to support the body.

II. LIGAMENTOUS SYSTEM.

§ 1285. The peculiarities of the ligamentous system are as follow:

1st. The ligaments of the lower extremities are stronger than those of the upper, and this strength increases progressively from below upward.

2d. The looseness of the cervical ligament, although the head is very much developed, in regard to the occipital foramen which is situated farther forward.

III. MUSCULAR SYSTEM.

§ 1286. The muscular system also furnishes several strong arguments.

1st. The greater power of the muscles of the lower extremities.

2d. The extreme force and arrangement of some of them, viz.

a. The thickness of the peronei muscles of the leg, the lower head of which always draws the leg backward and extends it, while the upper two prevent the body from falling forward.

b. The arrangement of the flexors of the leg compared with that of the flexors of the fore-arm; for one of the three long flexors of the first of these limbs is manifestly developed only in part; so that the number of the corresponding muscles in the fore-arm is much greater than in the leg.

c. The thickness of the glutæi muscles, particularly the glutæus maximus.

d. The multiplication of the muscles of the fore-arm to execute the peculiar motions of the bones of the fore-arm: so likewise the difference between the number and development of the special muscles of the thumb and little finger and those of the large and small toes.

e. The deeper situation of several of the muscles of the fore-arm in the upper extremity, and the foot only in the lower: such are particularly the flexor brevis and the extensor communis brevis.

f. The slight extent of the insertion of the flexors of the leg, which favors the extension of this limb and prevents the continued forced flexion it experiences in quadrupeds.

g. The smallness of the small muscles of the head, which in connection with the looseness of the cervical ligament and the anterior position of the occipital foramen, forms a very striking character, especially when we regard the great development of those parts in quadrupeds, the head of which is however smaller than that of man.

§ 1287. All these circumstances united prove sufficiently that the erect posture on the lower limbs is natural to man.

We must next examine how the erect posture is preserved in a state of repose, and how the body when erect exercises the motion of progression, or of *standing* and of *walking*, treating of the modifications of each.

B. OF STANDING.

§ 1288. The trunk and the lower limbs act in standing. The part taken by the trunk consists,

1st. In the support of the head by the vertebral column.

2nd. In the action of the very strong long muscles of the back which fill the channels between the vertebræ and the ribs. They prevent the body from falling forward, to which it is in some measure disposed from the portion of the pectoral and abdominal viscera before the vertebral column. In fact, they are much more developed in their lower part than at their summit. In this part also we feel fatigue and pain most sensibly after standing a long time and especially after leaning forward.

The trunk is supported by the lower extremities. Whenever the position changes the pelvis presents a broad point of support for its weight, and that of the head which is sustained by the vertebral column. The articulation of the ossa femoris with the iliac bones in front of their union with the spine increases the extent of this base of support.

In standing, the weight of the body passes from this base to the thigh, next to the leg, and finally to the foot, so that the body rests upon the latter.

In the usual position on the two feet, besides the peculiarities relative to the lower extremities and which we have mentioned above, their separation caused by the breadth of the pelvis and the length of the neck of the thigh bones is very advantageous, as it increases the extent of the base of support which falls between the soles of the feet; thus the attitude becomes unsteady and less firm when the breadth is diminished by approximating the feet.

Standing, inasmuch as it depends on the lower limbs, results from the action of all the muscles which arise from the trunk, and from the different sections of these members. These muscles contract from above downward, and thus move the divisions immediately above them, and act in a direction the inverse of that which results in progression, since they approximate the least moveable point to that which is most moveable. Thus the most active are, 1st, the glutæi, which draw the trunk backward; 2nd, the three flexors of the leg, which prevent the pelvis from inclining forward; 3rd, the extensors of the thigh, excepting the rectus, which prevent the limb from falling backward; 4th, the lower head of the triceps suræ, which keeps the leg on the foot in a direction intermediate between the flexion and extension.

The other muscles, which confine the action of those we have mentioned, have little or no action, and this action is counteracted by that of the others.

Standing on one foot, where the whole weight of the body rests on

one of the lower extremities, is practicable, especially by the length of the neck of the femur and the breadth of the sole of the foot. This posture of the body is preserved by the action of the muscles on the outside of the lower limbs, by the broad abdominal muscles, and by the quadratus lumborum, which act from below upward, preventing the body from falling to the opposite side, where it is unsupported.

In standing on the toes there is no change except in the relations of the bones of the leg and the action of its muscles. The toes are extended as much as possible on the metatarsal bones and the foot on the leg, and the weight of the body then rests wholly on the toes and also on the sesamoid bones of the foot, which are numerous and large. This position is caused principally by the simultaneous action of the muscles situated on the anterior and posterior faces of the leg and foot; the tibialis anticus, the peronei, especially the peroneus brevis, the extensors of the toes anteriorly, and the triceps suræ posteriorly, are the principal agents.

At the same time the toes are forcibly pressed against the ground by the action of their flexors, hence they are more firmly fixed and afford a more solid point of attachment to their muscles.

C. OF WALKING.

§ 1289. *Walking* is produced by the displacement of the lower extremities, which move alternately either forward, backward, or laterally, so that a distance exists between them, and consequently the rest of the body is supported by only one of them. Each motion, by which a limb is raised from the ground, separated from the other, and is replaced on the ground, is a *step*.

This motion, in whatever direction it is performed, depends principally on the displacement of the femoral articulation, which is flexed in walking forward or sideways, and, on the contrary, extended in walking backward.

When we walk forward or backward the knee-joint is generally slightly bent, which serves to raise the foot still more. The metatarso-phalangean joint is most generally forcibly extended, particularly when the lower limb which is to be moved is behind the other. In walking, the flexion of the haunch carries one of the two limbs more or less before the other; when left to itself, and the coxo-femoral articulation is not bent, the foot falls again to the ground and the step is finished. If we take long steps the pelvis also turns more or less around the limb which remains fixed as around an axis; hence the limb which moves, and the corresponding side of the body, are carried farther forward. The effect is caused partly by the flexion of the other sections of this limb and partly by the extension of the metatarso-phalangean articulation.

It is merely necessary to mention these motions to know the muscles which perform them.

Running is a quick walk, most generally with large steps, which differs from the ordinary walk not only by its rapidity, but also because all the lower face of the foot rests on the ground.

Jumping is a sudden movement by which the body rises into the air. In order to perform it all the joints of the lower limbs are flexed and then suddenly extended; from the shock which the body experiences from the soil against which it strikes it is carried upward until its weight exceeds the motion communicated to it, and causes it to return to the earth.

The leap in a straight line is always shorter than the oblique leap, because the weight of the body presents more resistance in the first case than in the second.

In *kneeling* the articulation of the foot is flexed by the anterior muscles of the leg, which act from above downward, and the articulation of the knee is changed in the same manner by the action of the upper heads of the triceps suræ muscle.

In *stooping* the gastrocnemii muscles of the leg exercise all their power; at the same time the coxo-femoral articulation is flexed more or less forcibly in order to lean the body forward, and to prevent its centre of gravity from falling behind its base of support, and in this manner to prevent its fall.

§ 1290. The *motions of the trunk** are very limited. This is proved by the vertebræ and also by the pieces of the sternum, which are firmly united. Thus the motions of the trunk in every direction depend but slightly on the displacement of the bones which form it, but almost entirely on the lower limbs, and those in the coxo-femoral articulation, are performed by the muscles which extend from the thigh and leg to the vertebral column and to the iliac bones. The mobility of the ribs is much greater; the changes in their situation produce the continual alternate changes which take place in the capacity of the chest, and which result in inspiration and expiration. The examination of these changes and of those which occur in the capacity of the abdominal cavity will be more in place after describing the pectoral and abdominal viscera than here.

§ 1291. The head moves on the vertebral column; it bends forward, is extended backward, inclines to the side, and turns on its axis.

The last two motions take place almost entirely between the second and first vertebræ, the last of which only accompanies the head. The other two occur between the head and the atlas, and not between the atlas and axis, because the odontoid process and the transverse portion of the crucial ligament almost entirely prevent every displacement in this direction between the first and second vertebræ.

Luxation cannot take place in flexion and extension on account of the firmness of the attachments; but it easily supervenes in the

* Winslow, *Sur les mouvemens de la tête, du cou et du reste de l'épine du dos*, in the *Mém. de Paris*, 1730, p. 492—508.

rotation of the first vertebra and of the head on the axis, when this motion is performed quickly.

The cervical portion of the vertebral column must always be fixed in order that these different motions may be executed.

§ 1292. The upper limbs are much more moveable than the lower both in regard to the trunk and their different sections, which doubtless depends on the arrangement of these bones and the ligaments. The motion of rotation on the axis particularly is much easier in the first than in the second. The greater mobility of the upper limbs, considered as a whole, is also increased by the difference remarked in the mode of articulation, of the first section of the bones of the two extremities, for the iliac bones are almost motionless on each other and on the vertebral column, while the clavicle and scapula on the contrary are very moveable both on each other and on the trunk.

Hence the motions of the upper limbs are not performed solely in the scapulo-humeral joint as those of the lower extremities are in the coxo-femoral articulation, but take place at the same time in the scapulo and sterno-clavicular articulations; hence they are not only more free, but also keep the bones together in the different motions they perform. Hence the bones are much less firm, but they require less strength, since the upper extremities are rarely obliged to sustain such heavy loads as happens for instance in creeping, walking, or standing on the hands.

If we except the fingers and toes, mobility diminishes from the periphery of the limbs to their centres.

A great difference between the partial motions of the two limbs consists in the power of turning the radius on its axis and around the ulna, while the leg cannot move around the thigh, except as a whole, the fibula being immoveable on the tibia. The leg is capable only of flexion and extension, while the fore-arm can execute also the motions of pronation and of supination.*

Although in the two latter motions the radius is the principal part displaced, the ulna is not however motionless; for it is slightly extended in pronation and a little flexed in supination.

* Winslow, *Obs. anat. sur la rotation, la pronation, la supination et d'autres mouvements en rond*, in the *Mém. de Paris*, 1727, p. 25-33.—Vicq d'Azyr, *Œuvres*, t. v. p. 343-351.

BOOK IV.

ANGEIOLOGY.

§ 1293. The vascular system* is composed of a central part, the *heart*, whence all the blood departs and where all this fluid returns; of vessels which carry it away, the *arteries;* and of vessels which

* We have already mentioned in our General Anatomy, the most important works on the general conditions of the structure and external form of the vascular system in the normal and abnormal state. We shall now mention the principal descriptive treatises. They are,

I. For the whole system.—J. C. A. Mayer, *Anatomische Beschreibung der Blutgefasse des menschlichen Körpers*, Berlin, 1777, 1778.—F. A. Walter, *Angiologisches Handbuch*, Berlin, 1789.

II. For the heart.—1st. Complete description of this organ in all its parts, both in the normal and abnormal state; Senac, *Traité de la structure du cœur, de son action et de ses maladies*, Paris, 1747, 1778.—2d. Complete description of it in the normal state; R. Lower, *Tractatus de corde, item de motu calore et transfusione sanguinis*, London, 1669.—J. N. Pechlin, *De fabrica et usu cordis*, Kiel, 1676.—Winslow, *Sur les fibres du cœur et sur ses valvules, avec la manière de le préparer pour le démontrer*, in the *Mémoires de Paris*, 1711, p. 196, 201.—Vieussens *Traité de la structure et des causes du mouvement natural du cœur*, Toulouse, 1711.—Santorini, *Obs. anat.*, Venice, 1724, ch. viii., *De iis quæ in thoracem sunt.* —Lieutaud, *Obs. anat. sur le cœur*, in the *Mém. de Paris*, 1752, 1754.—3d. Development of the heart; Meckel, *Sur l'histoire du développment du cœur et des poumons dans les mammifères*, in the *Journal complém. du Dict. des sc. medic.*, vol. i. p. 259.—Rolando, *Sur la formation du cœur et des vaisseaux artériels, veineux et capillaires*, same journal, vol. xv. p. 323, vol. 16, p. 34.—Prévost et Dumas, *Développment du cœur et formation du sang*, in the *Annales des sciences naturelles*, vol. iii. p. 46.—4th. Structure of the heart in respect to the arrangement of its fibres; C. F. Wolff, *Dissertationes de ordine fibrarum muscularium cordis*, in the *Act. Acad. Petropol.*, 1780—1781, in the *Nova act.*, vol. i.-viii.—J. F. Vaust, *Recherches sur la structure et les mouvemens du cœur*, Liege, 1821.—S. N. Gerdy, *Mémoire sur l'organisation du cœur*, in the *Journ. compl. du Dict. des sc. méd.*, vol. x. p. 97.—5th. Pathological state; A. Burns, *Observations on some of the most frequent and important diseases of the heart*, London, 1809.—Pelletan, *Mémoires sur quelques maladies et vices de conformation du cœur*, in the *Clinique chirurgicale*, Paris, 1810, vol. iii..—Testa, *Delle malattie del cuore, loro cagioni, specie, cura*, Bologna, 1810, 1813.—Corvisart, *Essai sur les maladies et les lesions organiques du cœur et de gros vaisseaux*, Paris, 1818.—Kreysig, *Ueber die Herzkrankheiten, au* Berlin, 1814, 1817.—Laennec, *De l'auscultation médiate*, or *Traité du diagnostic des maladies des poumons et du cœur*, Paris, 1819, p. 195-445.—Bertin, *Traité des maladies du cœur et des gros vaisseaux*, Paris, 1824.

III For the arteries.—Haller, *Icones anatomicæ*, Gottingen, 1745, 1756. —A. Murray, *Descriptio arteriarum corp. humani tabulis redacta*, Upsal, 1783, 1798.—J. F. S. Posewitz, *Physiologie der Pulsadern des menschlichen Körpers*, Leipsic, 1795.—J. Barclay, *A description of the arteries of the human body*, Edinburgh, 1818, 8vo.—Tiedmann, *Tabulæ arteriarum corporis humani*, Carlsruhe, 1822, 1824.—Hodgson, *Diseases of the arteries and veins.*

IV. For the veins.—Besides the tables of Loder see Breschet, *Sur le système veineux.*

V. For the Lymphatics.—The works mentioned in our General Anatomy contain also a description of this system.

return it, the *veins* and the *lymphatics*. The last mentioned carry a fluid different from the blood, they are the annexes or appendages of the venous system.

SECTION I.

OF THE HEART.

CHAPTER I.

GENERAL REMARKS.

§ 1294. The *heart* (*cor*) is a hollow muscle irregularly conical or pyramidal, situated in the centre of the chest, between the two lungs, and inclosed in a special envelop called the *pericardium*. Its vessels are numerous, but it has few nerves; it is formed of several cavities, some of which are separated, while others communicate together. Its tissue is formed of fibres united in superimposed layers, and is connected on one side with the large venous trunks of the lungs and body, and on the other with the large arterial trunks of both. Each of these characters deserves to be specially considered.

I. FORM.

§ 1295. The shape of the heart is that of a cone or an irregular pyramid. We distinguish in it a broad and thick *base* (*basis*) and a *summit* (*apex*), which is generally blunt and bifurcated, an upper and anterior face which is concave, and an inferior and posterior which is smaller and flatter; two edges, a posterior which is thick and pointed, the anterior is smaller, shorter, thin, and sharp.

The base of the heart is formed, properly speaking, by that part of the organ directly connected with the veins: we may then term it the *venous portion of the heart* (*pars cordis venosa*). However we generally apply the term *base of the heart* to the upper region of the arterial portion. The venous portion is formed of two auricles. It is separated from the next by a large groove, called the *groove of the base*, the *auriculo-ventricular groove*, or *circular groove* (*sulcus baseos*, s. *atrio-ventricularis*, s. *circularis*). Its form is an oblong square and its breadth exceeds its height.

The succeeding portion, which is situated before the auriculo-ventricular groove, is directly connected with the large arterial trunks. We may then term it the *arterial portion of the heart* (*pars arteriosa cordis*). It is formed by the two ventricles. It terminates in a blunt summit, which is usually more or less evidently grooved. This groove is sometimes very large.

The *longitudinal groove* (*sulcus cordis longitudinalis superior et inferior*) exists on both faces of the heart, from its base to its summit, and consequently in all its length.

The principal branches of the nutricious vessels of the organ are situated in these grooves: they communicate on the side of the base by a groove, which descends perpendicularly between the two auricles, and on the summit by the depression observed in this place. They mark the course of the *septum* within the heart (*septum cordis*).

§ 1296. The septum passes also across the venous portion of the heart or the auricles as well as its arterial portion or the ventricles. It separates completely these two synonymous parts, and consequently divides the heart into a *right* or an *anterior* and a *posterior* or *left* half. That part which passes between the auricles is called the *septum atriorum*, and that between the ventricles is called the *septum ventriculorum*. The right part of the heart is called the *pulmonary heart* (*cor pulmonale*), because the pulmonary artery arises from it, or the *heart of the black blood*, from the colour of this fluid within it. The left is termed the *aortal heart* (*cor aorticum*), because the aorta arises from it, or the *heart of red blood*, from the colour of the blood within it. We employ sometimes also the terms of *first ventricle*, to designate the anterior, and *second ventricle*, to mark the posterior; but these are less convenient.

II. WEIGHT AND SIZE.

§ 1297. The weight of the heart in a fully grown man is about ten ounces; whence it is to that of the whole body as 1 is to 200.

Its length, measured from the centre of the auricles, is between five and six inches; its mean length is five and a half inches, four of which are for the ventricles and one and a half for the auricles. The breadth of theventricles united is generally three inches at their base, and that of the auricles is three and a half inches.*

III. SITUATION.

§ 1298. The heart is placed obliquely from right to left, from behind forward, and from above downward; so that its base is nearly opposite

* A knowledge of the perfectly normal proportions of the heart in the healthy state is very important to the physician, since without it he can establish no certain diagnosis of the diseases of the central organ of the circulation. We cannot do better than to quote the following passage of Laennec on this subject: "The heart, including the auricles, should be equal to, a little less, or a little larger than the first of the subject. The walls of the left ventricle should be a little more than twice as thick as the walls of the right ventricle; they should not collapse on cutting into the ventricle. The right ventricle, a little larger than the left, presenting smaller fleshy pillars, although its parietes are thinner, ought to collapse after the incision." (*De l'auscultation médiate*, vol. ii. p. 270). "Reason teaches and observation proves, that in a well formed subject the cavities of the heart are nearly equal; but as the parietes of the auricles are very thin and those of the ventricles are much thicker, it follows that the auricles form only one third of the whole volume of the organ or the half of that of the ventricles." (*Ib.*) F. T.

the eighth dorsal vertebra, from which it is separated by the esophagus and aorta, and its summit corresponds to the cartilage of the sixth rib, or to the interval, which separates it from the next. Its lower face, which is flattened, corresponds to the upper face of the central tendon of the diaphragm, and the upper to the central and left portion of the anterior wall of the chest.

IV. TEXTURE.

§ 1299. The heart is formed of several layers of muscular fibres, situated between two thin, smooth, and polished membranes, the inner and outer membranes of the heart. The latter is the inner layer of the pericardium.

The outer surface of the heart is smooth and uniform in relation to the inner, even when we have removed the outer membrane.

The inner surface is very uneven and reticulated, which arises from its being formed of numerous rounded, flat, and distinct muscles, which intercross continually and which are called *fleshy pillars* (*trabeculæ carneæ*) The muscular substance of the heart is generally harder, more solid, and more elastic than that of other muscles.

As the arrangement of these fibres * differs wholly in the venous portion from what it is in the arterial portion, as it is not exactly the same in the right and left portions, and as it finally differs according to the subject, all that can be said generally may be reduced to the following corollaries: †

1st. The directions of the layers are more or less opposite. But in the recent state, far from being entirely separated from each other, they intercross differently; so that all those of one portion of the heart constantly contract uniformly and diminish the cavity they circumscribe in every direction.

The union of the different layers takes place partly by more or less manifest muscular fibres.

2nd. The fibres which form the layers are united in fasciculi of various sizes, which vary more or less in their origin and their direction, and which are often separated by greater or less spaces. These fasciculi are sometimes rounded and sometimes flattened,—a difference which seems to depend on determinate laws, since it is constant in the different regions of the heart. For instance the right and left ventricles

* Wolff, *De ordine fibrarum muscularium cordis, diss.* vii. *De stratis fibrarum universum. In nov. act. petropl*, vol. iii, 1785, p. 227-249.—Gerdy, *loc. cit.*, 101.—Vaust, *loc. cit.*, p. 102, etc.

† Gerdy has established a law, that all the fibres, whatever is their extent, situation, and direction, form webs which are convex toward the point of the heart, and which are nearly superficial at one extremity and deep at the other; so that for instance the external or internal fibres are the same reversed, and having passed through the thickness of the ventricle. The extremities of these muscular webs are constantly inserted in the base of the heart, around the different auricular and arterial orifices of the ventricles, either directly or by tendons attached to the auriculo-ventricular valves (*loc. cit.*, p. 101). F. T.

are not similar in this respect nor in regard to the arrangement of their fibres, and the same is true of other parts also. Thus the inner layers are generally rounded and form fleshy pillars. The auricular appendages of the auricles are formed of rounded fasciculi, and the auricles of flattened fasciculi.

From this arrangement we may deduce that the *firmest parts are formed of rounded fasciculi.* But the fibres and the fasciculi formed by them are united by intermediate fibres, which may be distinguished with facility.

The fibres and fasciculi are every where interlaced with each other, conformably with all the involuntary muscles. They are united principally in two ways: sometimes the ends of the fibres and fasciculi join, and sometimes they are united by intermediate filaments, which arise from their lateral portions.

In the first case, either the fasciculi go to meet each other and the extremities of those which continue together intermix like the teeth of a saw, as is the case with the digitations of several adjacent muscles, or some fibres are attached obliquely to others at acute angles, as the fibres of the penniform muscles are implanted in their tendons, and finally, as is the case most generally, the fibres or fasciculi which go side by side unite at very acute angles.

The lateral union takes place principally between the insulated fibres and the small fasciculi of fibres, especially in the outer layer. Sometimes it is irregular; so that those fibres which are evidently separated in the rest of their course are placed one against another in a part of this same course, whence the reticulated structure is more or less evident. It is sometimes regular, and we see oblique fibres going from each side, which unite. The redness and determinate form of the intermediate filaments always demonstrate that they are not formed of cellular tissue but of real muscular substance.

The mode in which the filaments are united also presents determinate differences in the different regions of the heart.

3rd. In the ventricles, the external layers go obliquely downward, backward, and from right to left. The direction of the central is opposite, and the most internal, which form the fleshy pillars, extend longitudinally from the summit to the base.

On the contrary, the transverse direction predominates in the auricles. The external layer, which is the strongest, proceeds in this direction, while the internal, which forms only insulated fasciculi, has a longitudinal direction.

4th. All the external layers are not equally extended. Generally the external layers are those only which cover all the surface of the ventricles; the central are smaller and occupy only a third of the heart. If we except the most internal, that which forms the fleshy pillars, they diminish in direct ratio to their depth. They disappear first at the summit of the organ, and in reascending from this point to the base of the ventricles, they are deeper and deeper; so that

the deepest are found only at the base. Hence this part of the heart is the thickest.

We observe also occasional spaces between the layers, which extend the whole length or all the breadth of the ventricles.

5th. The outer layers differ from the central ones, inasmuch as they are stronger and their fibres are more intimately united together.

Thus the fibres and the fasciculi of the inner layers are more easily demonstrated. But the external forcibly embrace and compress these latter; so that they contribute essentially to the firmness of the heart.

6th. The fibres of the two portions of the heart are not continuous, at least not all of them, with each other, so that the same layers are reflected on the two; but the fibres of the two ventricles terminate in the septum. The upper and lower faces of the heart are not arranged in precisely the same manner: the separation is seen with more difficulty in the first than in the second. We remark also three different arrangements in the upper face. In fact, either we cannot distinguish the least trace of separation and the fibres are uninterruptedly continuous with each other, or two fibres are in fact applied one on the other, but a species of suture serves as a line of demarcation between them, or finally they mingle with each other by digitations.

Wolff states that on the lower face, the fibres of the two ventricles are separated by a distinct and very broad band, formed of longitudinal fibres, and which diminishes insensibly from the base to the summit, to which these fibres are attached on the two sides. But we have usually found but a slight, and often no trace of this arrangement.

7th. The upper extremities of the fibres of the heart are attached to a fibro-cartilaginous tissue,* formed

a. Of two oblong, rounded projections or tubercles, usually three or four lines long, little less than a line thick, seen on both sides of the orifice of the aorta.

b. Of a thin band, which surrounds the posterior part of the circumference of the aorta and unites the two tubercles.

c. Of four filaments, placed in the circular groove on the base of the heart, two on the right and two on the left, an anterior and posterior on each side. Below these four filaments the two anterior arise from the tubercles. The right anterior goes into the anterior and upper part of the circular groove; the left into the upper and posterior part. The posterior two arise by a very short common trunk, which is only a few lines long, from the band which unites the two tubercles, near that of the right side, and proceed in an opposite direction to the lower part of the circumference of the circular groove.

These anterior and posterior filaments are situated at the venous orifices of the ventricles. They do not surround the base of the heart

* C. D. F. Wolff, *De ordine fibrarum muscularium cordis, Diss.* ii., *de textu cartilagine cordis, sive de filis cartilagineo-osseis eorumque in basi cordis distributione. In Act. Petropol.*, 1781, vol. i. p. 211.—Gerdy, *loc. cit.*, *du tissu albugine cardiaque*, p. 97.

and form a complete ring, but terminate near the edges of each orifice and gradually lose themselves in the cellular tissue.

This cartilaginous tissue is surrounded entirely by a thin, firm, but loose sheath, a real perichondrium. It is covered more externally by the outer membrane of the heart and internally by its inner membrane.

The external muscular or superficial fibres arise principally from the cartilaginous tubercles and filaments, and from the cellular tissue between the extremities of the latter; so that the fibres, which come from the tubercles and from the origin of the filaments, adhere to them very intimately, while the others are united only by a cellular sheath which surrounds them.

V. VESSELS.*

§ 1300. The blood-vessels of the heart are proportionally very large and are called the *coronary* vessels (*vasa coronaria cordis*). The coronary arteries and veins resemble each other in many respects:

1st. These vessels (the arteries) arise directly from the beginning of the trunks of the vessels of the body, or they (the veins) open directly into the heart.

2nd. They turn around the base of the heart in the circular groove, whence they send toward the summit large branches which arise at almost right angles: these go to the ventricles and proceed along the heart, while the others are smaller and follow an opposite direction, proceeding to the auricles.

3rd. The large trunks and the large branches extend on the outer face of the organ and ramify internally.

4th. The veins have valves at the places where they open but not in their course. There are two arteries of nearly equal calibers, while we find only a single large coronary vein, which is constant; but beside this last we observe several, which are smaller, which open directly into the heart, but not constantly, except into the right part of the organ, and particularly into the right auricle: they do not open, even, except into the septum, and they do not empty their blood into the left part of the heart,† as some anatomists have pretended, and among others Vieussens‡ and Thebesius.§ In fact, Abernethy has very recently supported this latter opinion, viz. that the venous blood of the heart mixes with the arterial blood which nourishes the body, without passing through the lungs; he has only modified it by saying, that these orifices of the coronary veins in the left portion of the organ serve principally to prevent repletion of the right portion in those cases where the passage of the blood through the lungs is obstructed; because,

* Haller, *De vasis cordis propriis*, Gottingen, 1737.—*Iteratæ observationes*, 1739.—Geisler, *Commentatio de sanguinis per vasa coronaria cordi motu*, Leipsic, 1743.

† Sabatier, *Sur les veines de Thebesius*; in the *Traité d'anat.*, vol. iii.

‡ *Nouvelles découvertes sur le cœur*, Montpelier, 1706.—*Traité du cœur*, 1715.

§ *De circulo sanguinis in corde*, Leipsic, 1708.—*De circulo sanguinis per cor*, Leipsic, 1759.

having injected the cardiac arteries and veins in a subject whose lungs were diseased, he has seen the fluid penetrate into the left ventricle by broad openings. But as generally injections, even when very fine, transude on all the inner face, although no venous orifices are perceptible on the left side, we have reason to admit that the openings existing in the cases observed by Abernethy were produced accidentally, either during life or after death, by obstacles to the course of the injection, on account of the feeble resistance of the tunics of the veins weakened by disease, and considerably distended, both by the blood accumulated in these vessels and by the injected mass.

VI. NERVES.

§ 1391. The nerves* of the heart are proportionally smaller than those of the voluntary muscles. They arise from the upper and lower cervical ganglions of the great sympathetic nerve, from the cervical portion of the nerve between these two ganglions, or from the central ganglion sometimes found in this place. Some arise directly from the nerve, others from the plexuses formed by the filaments which come from the ganglions and by others sent off by the pneumo-gastric nerve.

The relations of the nerves of the heart with its muscular substance have been the subjects of dispute. Some anatomists, Behrends† among others, deny that this substance, and consequently that the heart, possesses nerves, which they pretend are distributed only to the cardiac vessels. Others on the contrary, as Scarpa, Munniks,‡ and Zerrenner,§ maintain that they really go to the heart as well as to all other muscles.

The partisans of the first hypothesis adduce the following arguments:

1st. Anatomical examination, whence it results that the cardiac nerves, which we cannot follow except to the third ramification of the coronary arteries, do not enter the substance of the heart but go only to the arteries.‖

2nd. The origin of the cardiac nerves; they arise from the great sympathetic nerve, the ramifications of which go only to the arteries.¶

* J. E. Neubauer, *Descriptio nervorum cardiacorum*, Frankfort and Leipsic, 1772. He has figured the nerves of the right side.—E. P. Andersch, *De nervis; in the Nov. comm. Gœtt.*, vol. ii., and Konigsberg, 1797. He has represented those of the left side. These figures have been copied in Haase, *Cerebri nervorumque corporis humani reptita*, Leipsic, 1781.—A. Scarpa, *Tabulæ neurologicæ ad illustrandum historiam anatomicam cardiacorum nervorum cerebri, glossopharyngæi et pharyngæi ex octavo cerebri*, Pavia, 1794.

† J. Behrends, *Diss. quâ demonstratur cor nervis carere, additâ disquisitione de nervorum arteriis cingentium*, Mayence, 1792.—A. T. N. Zerrenner, *An cor nervis careat iisque carere possit?* Erford, 1794.

‡ *Observationes variæ. Diss. anat. med.*, Groningue, 1805, 1-17.

§ Zerrenner, *An cor nervis careat iisque carere possit?* Erford, 1794.

‖ Behrends, *loc. cit.*, pp. 5-8.

¶ *Id., ibid.*, p. 8.

3rd. The smallness of those nerves which is in direct ratio with the thinness of the fibrous coat of the arteries,* and which contrasts on the contrary with this law, that the number and size of the nerves correspond to the power and frequency of the motions of the muscles.†

4th. The insensibility of the heart, the motions of which are independent of the nervous system, since it beats regularly, although removed from the body,‡ and the excitement of the nerves, whether mechanically or dynamically, by means of galvanic electricity, do not alter its motions,§ and its pulsations are not deranged when the nervous system is paralyzed as in apoplexy.‖

5th. The integrity of the motions of the heart, notwithstanding the administration of opium.¶

But all these arguments can be refuted with greater or less facility. In fact:

1st. The manner in which the cardiac nerves are distributed and their proportion both to the muscular substance and to the vessels, do not differ essentially from what is seen in the same respects in the voluntary muscles.** Here also the nerves and the ramifications of the vessels are very compactly situated in regard to each other, and we do not see the nerves unite to the muscular substance. Besides the cardiac nerves are closely connected with the vessels only in their largest branches, and not at all in many animals.

2nd. The muscular substance of the heart is only a greater development of the fibrous membrane of the vascular system, so that the distribution of the branches of the great sympathetic nerve within it does not present an aberration from the type of this nerve.

3rd. The cardiac nerves possess more medullary substance than those of the voluntary muscles. They arise from the ganglions of the great sympathetic nerve, and through them from all the spinal marrow. Their action is probably favoured by the mutual contact of the blood and of the inner face of the heart; very probably also the size of the nerves which go to the voluntary muscles relates to their functions which is to conduct the influence of the will.

4th. The facts cited in the fourth paragraph are explained partly by the smallness and partly by the texture, especially the softness and gelatinous nature of the cardiac nerves, and from the circumstance that they arise from the ganglions. Besides they are correct only to a certain extent, since the motions of the heart are not entirely independent of the nervous system. The passions have a marked influence on the number and strength of its pulsations. Impressions of

* Behrends, *loc. cit.*, pp. 8, 9.
† *Id.*, *ibid.*, p. 10.
‡ *Id.*, *ibid.*, p. 11.
§ *Id*, *ibid.*, p. 20.
‖ *Id.*, *ibid.*, p. 12.
¶ *Id.*, *ibid.*, p. 11.
** Scarpa, *loc. cit.*, § 13.—Munniks, *loc. cit.*, p. 6.

every kind on the nervous system modify its motions more or less sensibly.*

In fact several observers, particularly Valli, Volta, Klein,† and Bichat, have doubted the influence of electricity on the motions of the heart; but the observations of Fowler, Schmuck, Pfaff,‡ Rossi,§ Giulio,‖ Humboldt,¶ Munniks,** and Nysten, and our own also, prove it to be real.

The non-affection of the heart in paralysis of the brain proves nothing in regard to the relations between the nerves and this organ, since the irritability of the voluntary muscles is not altered in apoplexy. This apparent difference depends only on that between the excitants of the voluntary and involuntary muscles. In fact the excitant of the first is the influence of the brain, and that of the second the substance contained in their cavity, which in the present case is the blood. The motions of the heart continue also in cerebral paralysis, while those of the other muscles are not performed; the activity of these last seems extinct while it is only no longer seen.

5th. The observations of Haller, of Fontana, of Whytt,†† and of Alexander,‡‡ prove that the heart, like the voluntary muscles, is sensible to the influence of opium, whether the narcotic acts directly upon it, or is placed in contact with the nervous system or with any organ whatever. These observations and experiments prove that the relation between the heart and the nerves is perfectly like that between the nerves and muscles generally, and more, because the effect of opium upon the heart is much more evident when this substance is placed in relation with the nervous substance than when applied directly to the heart.

VII. VENOUS PORTION.

§ 1302. The characters of the *venous portion* of the heart,§§ the auricles, are,

1st. The muscular substance of its parietes is so thin that the two membranes of the heart touch in several places.

2nd. Its form is irregularly quadrilateral.

* See on this subject Legallois, *Expériences sur le principe de la vie*, Paris, 1812.—Wilson Philip, in the *Phil. Trans.*, 1815, part i. pp. 65-97; part ii. pp. 224-246.—Id. *An experimental inquiry into the laws of the vital functions*, London, 1818.

† In Pfaff, *Ueber thierische Electricität und Reizbarkeit*, p. 119.

‡ In Pfaff, *loc. cit.* p. 140.

§ *Mém. de Turin*, vol. vi.

‖ Voight, *Magazin*, vol. v., p 161.

¶ *Ueber die gereizte Muskel-und Nervenfaser*, vol. i. pp. 340-349.

** *Loc. cit.*, p. 115.

†† In Pfaff, *loc. cit.*, p. 140.

‡‡ *Memoirs of the Manchester society*, vol. i. p. 98.

§§ Ruysch, *Epist. anat. problemata decima de auricularum cordis earumque brarum matricium structura*, Amsterdam, 1725.—A. F. Walther, *De structura ordis auricularum*, Lipsiæ.

3rd. It is composed of a part into which the veins open directly the *cavity of the auricle*, the *sac* (*sinus*), and another upper and anterior, the *auricular appendix* (*auricula*), which projects above the sac.

The exact limits of these two parts cannot be pointed out, or rather anatomists do not distinguish them according to the same principles on the right and left sides. On the left side the appendix is readily distinguished from the sac, because it suddenly forms a very rounded projection, which is much narrower, and has thicker walls on the upper anterior and left angle. On the right side, on the contrary, this name is applied to a part, the walls of which are very thick, which is formed on the left by the confluence of the two venæ cavæ, terminates above in a blunt summit, and which is not sensibly separated from the rest, while, if we remained true to the analogy, this term should be applied only to the small appendix which terminates the auricle above, and which is elevated on the left along the vena cava superior.

4th. It is directly continuous with the venous trunks which open into it.

VIII. ARTERIAL PORTION.

§ 1302. The characters of the *arterial portion* of the heart, the *ventricles*, are,

1st. Their parietes are thicker, so that the internal and the external membranes are everywhere separated from each other by a muscular substance. The thickness of the parietes of each portion of the heart is then in direct ratio with the extent passed through by the blood it sends forward.

2nd. The arterial portion is considerably larger and broader than the venous portion.

3rd. Its external form is elongated, rounded, and pyramidal, and determines, properly speaking, the form of the whole heart.

4th. At its upper extremity are two openings, the venous and the arterial, which establish the communication, the first between the ventricle and the auricle, and the second between the ventricle and the artery which arises from it. The venous orifice is almost perpendicular; its direction is from before backward and from right to left; the arterial is almost horizontal and is situated a little above the former farther inward and nearer the septum.

Both are rounded; the venous is broader than the arterial. Its form is elliptical, while the latter is nearly circular.

Neither the venous nor the arterial opening is perfectly loose; both have valves. The valves placed at the arterial opening are very similar in their arrangement to those found in the common veins; they are however much larger and are usually three in number. Their convex and attached edge looks toward the heart, while the loose edge, which has two concavities and which is thicker than the rest of the membrane, is turned toward the cavity of the artery. In the centre

of the latter we observe a fibro-cartilaginous *tubercle* (*nodulus*). The blood which comes from the ventricle pushes them toward the circumference of the artery and against its parietes. On the contrary, the blood which tends from its specific gravity to return from the artery into the ventricle separates them from these same parietes, their loose edges then touch, and they form a horizontal septum between the cavity of the artery and the ventricle, which prevents the reflux of the blood into the latter. The tubercles complete this septum and close the space in the centre of the artery between the three valves.

The valves of the venous orifice differ from those of the arterial opening, and from all other valves, since they are attached much more firmly, hence they close more completely the opening around which they are placed. A narrow cartilaginous ring, which is not however perfect, exists on all the circumference of the venous opening; this sometimes ossifies in advanced age, especially in the left portion of the heart, and is situated deeply between the muscular fibres of the ventricle and those of the auricle.

This is the *cartilaginous tissue* already described as the origin of the external muscular fibres of the heart. The venous valve is attached to this tissue by its posterior edge, but its opposite and uneven edge, unlike that of all the other valves, is not loose; many flat and solid tendinous filaments, which extend from the base to the summit of the heart, arise from the valve, on which they are often united or pass over it and go to the opposite part of the circumference of the heart, soon unite into larger cords, and are attached to the parietes of the heart, and principally to its fleshy pillars. As the latter shorten when the heart contracts, the different parts of the valves then approach each other and the opening is forcibly closed. It is necessary that the loose edge of these valves should be thus attached since they must resist not only the weight of the blood like the other valves, but also the action of the muscular parietes of the heart, which forcibly push forward the arterial blood.

5th. The arterial portion of the heart is divided into an upper and lower half, which are separated by the upper part of the valve of the venous orifice at the upper and posterior parts of the ventricles, and which blend together at the summit of the heart, so that the ventricles, although resembling externally an elongated cone, form in fact two arched canals, convex forward, and the greatest convexity of which corresponds to the summit, and are more extensive in this part than in any other.

6th. The reticulated structure of the ventricles is much more distinct than that of the auricles. Some of the fleshy pillars form rounded, elongated projections, terminating in blunt summits (*musculi papillares*), which go toward the base of the heart, and from the extremity of which several tendinous filaments proceed to attach themselves to the loose edges of the venous valves. Farther, those fleshy pillars which are attached by their two extremities, as well as those which have

one end loose, communicate with each other at intervals by tendinous fibres. The direction of the principal fasciculi is longitudinal, the smaller which unite the preceding are oblique. Near the summit the reticulated texture is more and more developed, and the parietes become thinner in the same proportion.

IX. RIGHT AND LEFT PORTIONS.

§ 1303. 1st. The right half of the heart is considerably thinner than the left. This difference is very striking between the two ventricles, where the relation is generally as one to four or to five. Even then we find, as between the auricles and the ventricles generally, that the power of the parietes is in direct ratio with the space passed through by the blood which comes from them. The greater thickness of the walls of the left ventricle determines the form of the whole arterial portion of the heart. The right wall formed only by the septum is convex, and the left appears fitted to it like a sling.

2nd. The substance of the right side, especially that of the ventricle, is softer and looser than that of the left side.

3rd. The right side is broader than the left after death.* This difference also is most marked between the two ventricles, but it is not yet determined if it exists constantly during life or supervenes only after death.

Many anatomists, particularly Lower,† Santorini,‡ Weiss,§ Lieutaud,‖ and Sabatier,¶ have adopted the latter opinion, while most others favour the first.

This hypothesis has been supported sometimes by the result of measurement, and sometimes by the fact that the left ventricle is as much longer as the right is broader, and sometimes by experiments and observations, from which it has been concluded that the right side appears broader after death, only because it is more distended by the blood which remains stagnant in the lungs from their inaction, while previously the passage of the blood from the left ventricle was not obstructed; whence the left ventricle seems to be narrower compared to the right, in proportion to the less quantity of pulmonary blood received by it through the pulmonary veins. In men and animals who have died suddenly from the injury of the large vessels, or of those which communicate with the right portion of the heart, when consequently this cause of the distention of the right ventricle did not

* Helvétius, *Sur l'inégalité de capacité qui se trouve entre les organes destinés à la circulation du sang, dans le corps de l'homme, et sur les changemens qui arrivent au sang en passant par le poumon*, in the *Mém. de Paris*, 1718, p. 222-281.

† *Loc. cit.*, p. 34.

‡ *Loc. cit.*, p. 144, 145.

§ *De dextro cordis ventriculo post mortem ampliore*, Altdorf, 1745.

‖ *Essais anat.*, p. 230, 231.

¶ *Sur l'inégale capacité des cavités du cœur et des vaisseaux pulmonaires*, in the *Mém. de Paris*.

exist, the capacity of the two portions has been exactly or nearly the same.* Finally, when the left ventricle is placed in the same condition by means of a ligature as is the right ventricle at the time of death; while on the contrary the blood is removed from the latter by cutting the pulmonary artery, or the vena cava, we find that the relation between the two ventricles is the inverse of that which commonly exists, that is, that the right ventricle is narrower than the left.†

The veins appear much larger than the arteries after death, undoubtedly from the same cause.

To these experiments we may add that we sometimes find the right ventricle narrower than the left from the effect of disease, such as ossification or some other malady of the valves of the aorta, in which case the difference must be explained precisely in the same manner. We have before us several preparations in which, beside a considerable dilatation of the left ventricle arising from this cause, there is at the same time a great contraction of the right ventricle, proving that the results drawn from these facts cannot be opposed, by saying that the dilatation of the right cavity of the heart in the usual state of things should extend also to the left portion from the influence which it exercises on the veins and arteries of the body, and consequently that the right half is really larger during life since the left is itself distended. Since the cause of the greater distention of the right portion, that is, the more difficult passage of blood through the lungs, supervenes only at the moment of death, the opinion that the right ventricle is also more capacious during life cannot be sustained.‡

That the cause above mentioned is that which increases the capacity of the right portion of the heart at the period of death only, is proved by the fact that the difference between the two portions of the organs varies with the cause of death, and that it increases in a direct ratio with the increase of the obstacle to the circulation of the blood in the lungs. Thus, in those animals killed by drowning, hanging, and suffocation, Colman has found the right ventricle generally twice the size of the left, although its proportions commonly mentioned are much smaller.§ In fact, Haller asserts that in one subject he found it three times as large as the left,‖ but the usual estimates are much less than this. Gordon says the relation is sometimes as 5 : 4,¶ Lieberkühn as 3 : 2,** Portal as 7 : 5,†† Helvetius‡‡ and Legallois,§§

* Weiss, *loc. cit.*—Sabatier, *loc. cit.*
† Sabatier, *loc. cit.*
‡ Haller, *Elem. phys.*, vol. ii. p. 134.
§ *On suspended respiration from drowning, hanging, and suffocation*, London, 1791.
‖ *Loc. cit.* p. 133.
¶ *System of human anat.*, vol. i. p. 38.
** Hamberger, *Physiologie*, p. 708.
†† *Mém. de Paris*, 1770, p. 245.
‡‡ *Loc. cit.*
§§ *Dict. des sc. méd.* vol. v. p. 440.

as 6 : 5, Brown Langrish as 11 : 10* Gordon has found the two ventricles nearly equal in some cases,† and Portal asserts that their capacity is the same in young people.‡

These differences in the estimates of authors furnish a new argument against the common opinion, since we should presume that they depend on greater or less accidental obstacles to the pulmonary circulation.

We cannot however deny but that the capacity of the right portion of the heart is a little greater than that of the left, because the blood brought by the vena cava has received the fluid contained in the thoracic canal. It is also proved by the difference relative to the age in the degree of disproportion, this being, directly after birth, less than at a more advanced period of life.§

Legallois has also found the right portion of the heart a little broader than the left in every kind of death, both after strangulation and from the loss of blood.‖ The facts related prove only that the right portion of the heart can contract as much as, and even more than the left, in certain circumstances, and that the left is also susceptible of becoming larger than the right, but not that the capacity of the latter exceeds that of the former during life.

4th. The fibres of the right side, especially those of the ventricle, are not arranged in the same manner as those of the left side.

a. The thinness of the right ventricle is attended also with fewer fibrous layers, a fact already pointed out by Senac,¶ but which Wolff has indicated more precisely in saying that the right ventricle is formed of three layers only, while that of the left side presents six, counting the fleshy fasciculi of its internal face.** We have not however been able to find this number of layers. Usually we have observed on each side only three distinct layers, two oblique, and one internal longitudinal.

b. The fibres of the right ventricle are flatter and thinner than those of the left. Thus the former form flattened fasciculi, and the second rounder and thicker fasciculi. The latter ramify more ; they are separated by fat, and have spaces between them, while we can hardly distinguish the former from each other except by the direction of their fibres.

c. The fibres of the right ventricle are more oblique and annular, while those of the left are more longitudinal.

d. The layers of the right ventricle, although thinner, are much more distinct than those of the left ventricle ; besides the latter are still

* *De part. corp. hum. fabric.*, vol. ii. p. 133.
† *Loc. cit.*, p. 38.
‡ *Loc. cit.*
§ Portal, *loc. cit.*
‖ *Tr. du cœur*, vol. i. p. 200.
¶ *De stratis fibrarum cordis in universum*, in the *Nov. act. Petrop.* vol. iii. an. 1785, p. 234-238.
** *Loc. cit.*, p. 234.

more similar in regard to direction, which doubtless contributes to make the left ventricle firmer, but proves at the same time that we should exercise some judgment in determining the number and direction of these layers. Such at least is the positive result of our researches. This also is the opinion of Wolff himself, who has studied the arrangement of the heart with too much exactness.

5th. The primitive form of the heart, that of a canal curved on itself, is more evident in the left ventricle than in the right.

6th. The nerves of the left side are larger and more numerous than those of the right side.

CHAPTER II.

SPECIAL REMARKS OF THE HEART.

§ 1304. We usually describe first the right half of the heart; and in order to follow the direction of the circulation of the blood, we begin with the right auricle.

I. RIGHT AURICLE.

§ 1305. The *right auricle* (*atrium anterius*, s. *venarum cavarum*, s. *dextrum*), forms that portion of the base of the heart situated farthest on the right and forward.

Its form is almost square; the vena cava superior descends obliquely from right to left, and from behind forward, towards its upper and right angle, and the vena cava inferior ascends in a contrary direction towards its lower and right angle. Notwithstanding this difference in the direction of the two venæ cavæ, we must admit that they unite and form a single trunk in the cavity of the auricle, for they unite on the right forward and backward, and the absence of the left side of their circumference is only apparent, since this side in fact exists, but is dilated to produce the muscular part of the auricle. The upper and left angle of the latter extends into a small blunt appendage, formed like a rounded square, which is observed before the lower part of the aorta. The lower and left angle is rounded.

We observe transverse fibres on all the circumference of this auricle, directly below the inner membrane of the heart, which, becoming thinner and separating from each other above and below, are prolonged for a small distance around the superior and inferior venæ cavæ. They are thinner where they surround the point of union of the two venæ cavæ forward, and are extended more uniformly, and are smoother on the right side, both on their outer and on their inner face.

But the left part of the posterior face of the anterior and unattached wall of the right auricle, which is the most extensive, is uneven internally. This unevenness depends on much larger and transverse fasciculi,

which are united by other smaller oblique fasciculi, so as to present a reticulated appearance. These fasciculi, with which the transverse fibres of the auricle are united, appear between two longitudinal smooth bands which proceed only along its internal face. One of these two bands, the left, descends a short distance from the anterior part of the venous orifice of the left ventricle ; the other, the right, situated almost in the centre of the anterior wall, a little however to the right, descends toward the left side, along the union of the two venæ cavæ. These fleshy fasciculi have been called the *pectinæal muscles* (*M. pectinati*).

The posterior wall of the right auricle forms the anterior face of the interventricular septum. We discover in it several remarkable parts, some of which belong to the history of the development of the heart.

On the right side and towards the centre is the *fossa ovalis* (*fossa ovalis*, s. *valvula foraminis ovalis*, s. *vestigium foraminis ovalis*), an oblong and rounded depression, which varies much in size. This fossa is very distinct from the posterior wall of the auricle at its upper part, a little less so on its sides, especially on the right, and is generally blended with it below, particularly on the right side. The more extensive it is, the less evident are the limits which separate it from the other parts of the posterior wall. It however not unfrequently presents a similar arrangement even when it is very small.

Most generally it exactly fills the space between the edges of the projection which surrounds it, and it is very tense, but not unfrequently it is much larger, and forms a valve, the loose edge of which corresponds to the left auricle. We almost always observe a greater or less depression above, between its extremity and the upper part of the projection which surrounds it. Very often also we see in this place one or more openings by which the cavity of the two auricles communicate. This arrangement is not constant, and it is entirely independent of the extent either of the valve or of the depression, although it occurs particularly when the valve is very broad. Even when the openings are large and numerous, they seldom descend below the central part of the projection which surrounds the depression, so that the septum of the auricles is complete in regard to the separation of the blood contained in the two cavities.

This place, especially in its upper part, is the thinnest portion of the septum and of the auricle generally. We however always observe muscular fibres between the two layers of the internal membrane of the heart, that of the right and that of the left auricle.

The projection which surrounds this depression is formed of reticulated muscular fibres. It is called the *ring* or the *isthmus of Vieussens* (*annulus*, s. *isthmus Vieussenii*). Its right portion separates the right and left halves of the septum. Although it does not project at its lower part, it is however complete in this place also.

We observe in its circumference several openings of the cardiac veins, called the *foramina of Thebesius* (*foramina Thebesii*). At the

lower end of the inferior edge of the ring a circular fold of the inner membrane of the right auricle commences, this is called the *Eustachian valve*, or the *anterior valve of the foramen ovale* (*valvula Eustachii*, s. *foraminis ovalis anterior*).* This fold extends more or less to the right, along the anterior part of the orifice of the vena cava ascendens into the right auricle, so that its lower edge is concave and attached while the upper is convex and loose within the right auricle. It imperfectly separates below the right and left halves of the right auricle.

This valve varies much in regard to size, form, and texture. It is usually more perfect and proportionally larger in the fœtus than at any time after birth. In the adult it is often entirely changed, at least at its upper part, into a reticular tissue, and in many cases some filaments only trace the valve, and these frequently do not exist. It usually contains some muscular fibres, but it is often only a simple fold of the internal membrane.

An intimate relation generally exists between the Eustachian valve and the fossa ovalis, the former being more developed in proportion as the septum formed by the latter between the two auricles is less perfect, and *vice versa*; but to this rule there are numerous exceptions.

The valve acts principally in the fœtus. At this period of life it conducts the blood of the vena cava superior toward the opening of the septum or the foramen ovale. Hence the relation between it and the valve of this opening.

In the adult it may prevent to a slight degree the reflux of the blood from the vena cava superior, and from the right auricle generally into the vena cava inferior. Directly at the left side of the left branch of the isthmus of Vieussens, between this branch and the venous orifice of the right ventricle, there is a large and rounded opening, the orifice of the *large coronary vein of the heart* (*orfiiavm venæ coronariæ cordis magnæ*).† This opening is sometimes divided more or less distinctly into several, and generally is more or less perfectly closed by a valvular fold, which arises at its lower part. This fold, called the *valve of Thebesius* (*valvula Thebesii*), has its upper and concave edge unattached, while its lower and convex edge adheres. Sometimes it does not exist; in other cases it is replaced by one or more imperfect transverse bands; finally, in some subjects there are several, even as many as six, situated one behind another.

* Winslow, *Description d'une valvule singulière de la veine cave inferieure, à l'occasion de laquelle on propose un sentiment nouveau sur la fameuse question du trou ovale, in the Mém. de Paris*, 1717, p. 272. *Eclaircissement sur un Mém. de Paris*, 1717, *Ibid.* 1725.—Haller, *De valvulâ Eustachii*, Gottingen, 1737.—L. Crell, *De valvulâ venæ cavæ Eustachianâ*, Wittenberg, 1737.—Brendel, *De valvulâ Eustachianâ inter venam inferiorem dextramque cordis auriculam positâ*, Wittenberg, 1738.—Haller, *De valvulâ Eustachii progr.* ii. Gottingen, 1748.—J. M. Diebolt, *De foramine ovali*, Strasburg, 1771.—J. F. Lobstein, *De valvulâ Eustachii*, Strasburg, 1771.—C. F. Wolff, *De foramine ovali ejusque usu in dirigendo sanguinis motu observationes novæ*, in the *N. C. Petrop.* vol. xx. p. 357.—H. L. Leveling, *De valvulâ Eustachii et foramine ovali*, in the *Obs. anat. rar. fasc.* i. 1786.

† Wolff, *De orificio venæ coronariæ magnæ*; in the *Act. Petrop.* 1777, p. 234-257.

II. RIGHT VENTRICLE.

§ 1306. The *anterior*, *pulmonary*, or *right ventricle* (*ventriculus anterior*, s. *dexter*, s. *pulmonalis*) is composed of an upper and lower portion, which are separated by the upper part of the venous valve. The former unites directly to the right auricle, the latter to the pulmonary artery, and its walls are thinner than those of the former. It terminates in a conical extremity, which projects upward and backward above the left ventricle and the septum of the heart. The pulmonary artery arises from this part.

The internal or posterior wall is formed by the septum of the heart and is slightly convex; the anterior is still more so. The posterior wall is smoother than the anterior at its upper portion and very often entirely so below the arterial opening. The net-work formed by the projecting muscular fasciculi is much more complete toward its summit than toward its base.

The anterior wall of the pulmonary ventricle is thinnest above toward the septum and thickest below also near the septum. Its thickness when the heart is strong and not very much distended is more than two lines, but less than this in the latter point. The two parts are scarcely a line thick even in those hearts which are neither very much distended nor small.

The quantity of blood in the right ventricle after death varies from one ounce and a half to three ounces.

§ 1307. The *venous valve* of the right auricle arises from the circumference of its venous orifice. It is called the *tricuspid valve* (*valvula triglochis*, *tricuspis*,) because, although it forms a single membrane, it is higher in three points than in the short spaces between them, and thus three slips are formed.

Of these, one, which is the largest, arises from the external and anterior part of the circumference of the venous orifice. The other two are smaller and arise from the inner and posterior part of this circumference, one over the other; so that consequently there is an external and larger slip, and two internal, an upper and a lower slip.

The last two are separated from each other by a space not so deep as those between them and the external. It is then more correct to admit only two slips, an anterior and external and a posterior and internal.

The first is much higher than the second.

The tendinous filaments of the upper extremity of the anterior or external slip are attached to this upper part of the septum. They are few in number. We usually find in the space only one or at most two short muscles, to which are attached those filaments farthest to the left; the others are inserted in its smooth wall. Most of those filaments which come from the central and lower parts of the edge of

this slip are attached to the summits of five or six of the fleshy pillars coming from the middle and lower parts of the anterior wall.

The filaments which arise from the posterior slips are mostly attached to the smooth folds of the septum, except a few, which are inserted in two or three small fleshy pillars, all of which except the lowest come from the septum.

The arterial orifice generally extends about three fourths of an inch higher than the venous. The sigmoid valves are thin. Their *tubercles* (*noduli Morgagnii*) are slight swellings, which however are often well marked in the young fœtus.

III. LEFT AURICLE.

§ 1308. The *left, posterior,* or *pulmonary auricle* (*atrium sinistrum*, s. *posterius*, s. *venarum pulmonalium*, s. *aorticum*) is of an oblong square form, considerably more broad than high.

It is separated below and posteriorly from the left ventricle by a circular groove, upward and to the right from the right ventricle by a similar depression. The pulmonary artery, the aorta, and the vena cava superior are also found upward and outward, between it and the right ventricle; so that the external part of its right and left extremities is alone visible.

Its upper left angle rises into an auricular appendage (*auricula sinistra*), which goes forward to the left and upward, directly behind the pulmonary artery, separating very much from the rest of the auricle. This appendage, which is narrower, longer, and on the whole larger than that of the right auricle, is circumscribed by rougher edges. It curves three or four times and finally terminates in a sharp summit, below and before the pulmonary artery.

The posterior wall of the lower part, the *sinus of the auricle* (*sinus venarum pulmonalium*), receives where it is continuous with the lateral parietes the four pulmonary veins, two on each side, the upper being larger than the lower. One of the two veins of the same side opens directly above the other, while between those of the two opposite sides is the whole breadth of the auricle; so that the two pairs occupy the whole height of the posterior wall.

The parietes of the whole auricle are muscular and formed principally of transverse fibres. They are smooth with the exception of the appendage. We observe in its whole length an anterior and a posterior series of very prominent transverse fasciculi, united by other smaller and oblique fasciculi, which proceed between two longitudinal bands, situated one on the right the other on the left.

The anterior wall is formed by the septum of the auricles and is also, like the posterior face of the septum, irregular in another respect. In fact we there observe a constant semicircular valve, which is however more or less developed. This valve leaves the upper edge of the transparent point which corresponds to the fossa ovalis of the right auricle. (§ 1305). It is turned upward and toward the left. Its lower edge

is convex and attached, and its upper edge is loose in a greater or less extent. Sometimes there is only a slight projection in its place.

This valve extends behind the interauricular septum. Its lower edge is attached to the posterior face of the centre of the isthmus of Vieussens, and the space between it and this isthmus forms a small cavity (*sinus septi*), which terminates below in a cul-de-sac. This is only the upper part of the valve of the foramen ovale (§ 1305), which in the normal state always ascends on the posterior face of the isthmus. Of this we are readily convinced when it does not adhere to the isthmus in the centre; for then the continuity is totally uninterrupted.

IV. LEFT VENTRICLE.

§ 1309. The *left ventricle* (*ventriculus sinister, posterior*, s. *aorticus*) is the strongest of all parts of the heart and forms its figure. Its posterior wall and its anterior wall which forms the posterior face of the septum, are convex externally and concave internally; so that its whole form is oval. The internal face of the posterior wall is very much reticulated; the anterior wall is smooth at its upper part and reticulated in the lower, but less so than the posterior wall. The fleshy pillars are rounded.

The thickness of the parietes is less toward the summit and greater at the base than in all other parts. In the adult it is five or six lines thick at the base and only three at the summit.

The capacity of the left ventricle varies in the adult from eight to twenty drachms.

§ 1310. Before the round venous orifice we find the *mitral valve* (*valvula mitralis*), composed of an upper and a lower slip. The upper arises directly below or rather before the ring of the sigmoid valve of the aorta, and is attached by slips to three or four fleshy pillars, which all come from the internal face of the posterior wall of the ventricle, some above, others below, and among which we distinguish two particularly, an upper and a lower, which are much larger than the others. The inferior and external slip, which is much narrower, is attached by tendinous filaments to a short but very thick fleshy pillar.

All these fleshy pillars arise from the posterior wall of the left ventricle; so that those of the upper slip arise near the summit of the heart, and cover those of the lower, so that we cannot perceive the lower slip until we have removed the upper or have detached it from its fleshy pillars.

The orifice of the artery is situated directly over that of the vein. Its sigmoid valves are thick and are generally supplied with tubercles (*noduli Arantii*), which are very distinct.

V. SEPTUM.

§ 1311. In the normal state the septum of the heart completely separates its two halves, even when the valve of the foramen ovale is not united with the isthmus of Vieussens at its upper part. In the venous portion of the heart it is much thinner than the auricles, which it separates, and is much lower, as they project above it. It is not muscular in every part, and generally there are no muscular fibres in the upper part of the old valve of the foramen ovale.

In the arterial portion, on the contrary, the septum is very muscular and is formed almost entirely by the fibres of the left ventricle. It projects considerably into the right ventricle, while in its posterior face, which forms the anterior wall of the left ventricle, there is a deep depression. Its height equals that of the ventricles. It is triangular and terminates in a point toward the summit of the heart. It is generally from four to five lines thick, and even more than half an inch thick in those parts where the large fasciculi project above the surface in those subjects which have large hearts. It is thickest below the orifices of the large arterial trunks, and thinnest beyond this point toward the interauricular septum. It is almost always weaker at the summit, where the layers which constitute it are less compact and more easily separated from each other.

CHAPTER III.

OF THE PERICARDIUM.

§ 1312. The *pericardium* (*pericardium*) (§ 1293) * is a fibro-serous membrane (§ 354), which entirely envelops the heart and the origin of the large vessels, and unites them with the adjacent parts.

The fibres which strengthen its outer layer and which are very apparent in old men, arise from the central aponeurosis of the diaphragm and extend longitudinally over the serous membrane. They are very much developed, particularly forward and upward.

Its lower face, which corresponds to the lower and flat face of the heart, is intimately united to the upper face of the central aponeurosis of the diaphragm by a very short cellular tissue.

It is covered on the sides and forward by the inner walls of the pleuræ.

Behind, it is attached to the œsophagus and to the root of the right lung.

* J. M. Hoffmann, *Diss. de pericardio*, Altdorf, 1690.—A. B. Heimann, *De pericardio sano et morboso*, Leyden, 1729.—Lanzoni, *De pericardio*; in *Opp. omn.*, Lausanne, 1738.

§ 1313. The pericardium incloses not merely the heart but also the origins of the large vessels, whence it is reflected on itself in every direction to arrive at the centre of the heart.

When examined from before backward and from above downward, we notice the following arrangement:

It envelops the aorta and the trunk of the pulmonary artery forward for about two and a half inches, unites these two vessels very closely, and passes uninterruptedly from one to the other; so that the corresponding parts of their circumference are retained by a cellular tissue.

The posterior part of these vessels is not covered in the same extent by the pericardium.

From the aorta this membrane passes to the right on the vena cava superior, to about an inch above its entrance into the right auricle, descends obliquely from left to right on its anterior portion, then arrives at the right pulmonary veins, on which it descends to about half an inch from their entrance into the left auricle, then goes on the anterior part of the vena cava inferior, directly below its opening into the right auricle, and wholly surrounds it except a small part of its posterior portion. Thence it goes to the left, on all the surface of the left pulmonary veins, and finally covers the left branch of the pulmonary artery below.

From all these parts the pericardium is reflected on itself. It adheres feebly to the large vessels, but much more strongly to the auricles and ventricles.

As in all other serous membranes, the inner and reflected portion of the pericardium is thinner than the external. It closely envelops the surface of the parts enclosed by the membranous sac, and, except in those parts where it is reflected, it is entirely separated from the outer layer, although they touch; so that the circumference of the heart is perfectly loose and is attached only by its upper part.

CHAPTER IV.

OF THE DIFFERENCES OF THE HEART WHICH DEPEND ON THE DEVELOPMENT AND ON THE SEX.

§ 1314. The differences presented by the heart in regard to its development are considerable.* They relate to its *volume*, *situation*, *form*, and *texture*.

1st. *Volume*. The heart is much larger in proportion to the body in the early periods of life than at a more advanced period. The relation

* The principal works on this subject are mentioned in Danz, *Grundriss der Zergliederungskunde des ungebornen Kindes in den verschiedenen Zeiten der Schwangerschaft*, vol. ii. Giessen, 1793, pp. 185-188.—See also Meckel, *Mémoire sur le développement du cœur*; in the *Journal complémentaire*, vol. i. p. 259.—Rolando, *Mémoire sur la formation du cœur*; same journal, vol. xv. p. 323, vol. xvi. p. 34.

etween it and the body is as 1 : 120 in the full grown fœtus and in he early years of life, while before this period, in the second and hird month of pregnancy, it is as 1 : 50.

2nd. *Situation.* At first the heart is not oblique, but its summit looks irectly forward and a little downward. It is only at the fourth month iat it begins to turn slightly toward the left side.

3rd. *Form.* The differences in its form are the most important and late both to the circumference of the whole organ and to the mode of niting its cavities. Observers have not decided whether there is or not in the human fœtus a period very near its origin, when the heart rms only a single cavity, composed of several compartments placed ar each other. But if this period exists, it passes rapidly, since all e external parts are developed in the fœtus at the end of one month.

A. OUTER CIRCUMFERENCE.

a. At first the arterial portion of the heart is much smaller in proportion to the venous. The right auricle especially remains for a long ne the largest portion of this organ. The permanent relation however begins to establish itself during the last half of uterine existence.

b. The arterial portion is at first flat and rounded: soon however breadth exceeds its length. Its summit is at first single and blunt; t as it enlarges it bifurcates. This phenomenon depends on the fact at the right ventricle from its situation does not at first concur to m the summit of the heart; but it gradually extends downward and nains separated from the left ventricle by a considerable depression. is groove sometimes continues during life, but almost always disppears after the middle of uterine existence.

c. The right ventricle is at first much smaller than the left: they soon equal in size: for a certain time the right ventricle is even a le larger, but it becomes smaller during most of uterine existence; that it is narrower in the full grown fœtus and in the young child. e greater size of the right ventricle seems to result from the obstas which often disturb the pulmonary circulation at an advanced iod of life.*

* This at least has been observed by Portal (*Sur la capacité des ventricules du r*; in the *Mém. de Paris*, 1770, pp. 244-246). In the heart of a full grown s the left ventricle contained seven drachms of water, while the right contained y six and a half. The capacity of the two ventricles was the same in that of a ng child; in that of an adult the right ventricle contained eighteen drachms ater, and the left only seventeen. The experiments of Legallois (*Dict. des sc. d.*, vol. v. p. 440,) prove that we can introduce

		grs. of mercury
an adult,	Into the right ventricle,	1172
	Into the left ventricle,	1068
a child,	Into the right ventricle,	828
	Into the left, not softened by pressure,	658
	Into the left, softened,	822

d. In the early periods of life the upper and pyramidal extremity of the upper part of the pulmonary ventricle is less distinct from the rest of the organ than at more advanced periods: it elevates itself also less above the left ventricle and the septum. This peculiarity is very curious, as precisely the contrary is seen in many mammalia, especially the ruminantia and the hog.

B. INTERNAL ARRANGEMENT OF THE HEART.

The principal difference presented by the heart in this respect is, that its septum is imperfect in the early periods of life, whence its right and left portions then communicate with each other.

a. The interauricular septum is perforated during all fœtal existence by an opening called the *foramen ovale.* This foramen is much greater as the fœtus is younger; so that we may consider the septum as primitively deficient and the two auricles then form a single cavity. The foramen ovale gradually grows smaller and occupies the lower and central part of the septum. The Eustachian valve is found very early directly before it and on the right, so as to occupy all its height. Hence as it arises from the anterior part of the circumference of the vena cava inferior, it separates the right and left auricle in such a manner, that this vein empties directly into the left auricle only. On the contrary, there is no trace of the closing of the foramen ovale on the left side till the commencement of the third month. But about this period this foramen begins to be obliterated by the formation of its valve, which arises from the posterior part of the vena cava.

		grs. of mercury
In a still-born child - - - - - - -	Into the right ventricle,	34
	Into the left ventricle, not softened, - - - -	37
	Into the left, softened, - -	78
In a seven month's fœtus, - - - - -	Into the right ventricle,	23
	Into the left, not softened, nor flaccid, - - - - -	34
In another about the same age - - - -	Into the right ventricle -	21
	Into the left, softened, -	54

In repeating these experiments, also with mercury, we have obtained the following results:—

	R. ventricle		L. ventricle		L. auricle		R. auricle	
	oz.	drs.	oz.	drs.	oz.	drs.	oz.	drs.
In a man 50 years old, - -	30		10		25		20	
In a woman 46 years old, -	40		22	4	22		15	
In a woman 40 years old, -	55		40		41		35	
In a man 34 years old, - -	32		15	4	21		25	
" 30 years old, - -	32	4	28	4	25		22	4
" 26 years old, - -	28		24	4	20		18	
In a boy 16 years old, - -	41	4	21	4	37		29	
In a girl 7 months old, - -	2	4	1	4	1	6	1	6
In a new born boy which had breathed, - -	1	6	2		1	5	1	2
In a still-born boy, - -	1	4	2		together 4 ounces.			

As this enlarges, the Eustachian valve diminishes and recedes from he septum, while on the contrary that of the foramen ovale approaches . The latter also becomes narrower and more tense, especially in the tter months of pregnancy; so that it closes the opening more exactly. he termination of the vena cava inferior in the heart suddenly changes, d this vessel empties itself no longer into the left auricle but into the ght. This change is also favoured by that which takes place in the tuation of the heart, which varies so that its summit corresponds to e left; the right auricle is more than usually elevated above the vena va inferior, at the same time that the Eustachian valve is removed om the septum and is carried forward.

The valve of the foramen ovale increases from below upward along e lateral edges of this foramen. At the sixth month of pregnancy it s already arrived at its upper part; it then passes beyond it; so that e interauricular septum is entirely filled, except a small space, which no longer an opening but a very short canal, formed forward by the per part of the ring of the foramen ovale and backward by the upper rt of the valve.

. It is not yet well demonstrated whether the ventricles, like the au- les, form a tfirst only a single cavity without a septum, although the velopment of the heart in the animal series, and the deviations of mation of this organ, lead us to this opinion. We have always nd a trace of the interauricular septum at the summit of the heart, en in the youngest fœtuses we could examine. During the first two nths however, or at least till the middle of the second, this septum sents at its upper part a foramen, at first rather large, but it gradu- y diminishes, and is found below the origin of the large vessels, so t the two ventricles form only one, which is imperfectly divided o two portions. This opening is obliterated at the period when the ery which arises from the ventricles becomes double, instead of gle, as it was at first; that is, when the pulmonary artery, which ore was blended with the aorta, becomes a proper and distinct ves- . Its obliteration then much precedes that of the foramen ovale.

4th. *Texture.* The thickness of the parietes is much greater com- ed to the size of the cavities during the early periods of life than sequently, and the greatest size of the heart then depends on this se.*

The parietes on both sides are then equally thick. The difference ich always exists afterwards, and which is scarcely perceptible even a full grown fœtus, does not begin to be developed till the second lf ofuterine existence.

The fibrous texture and the different layers of fibres are always re apparent at the early periods of life than at a more advanced age.

* Gordon is mistaken in saying that the parietes of the heart are proportionally ner in the early periods of life than at a more remote period (*System of human tomy*, vol. i. p 53.)

5th. *Colour.* The colour of the heart is much brighter when the subject is younger.

No fat has as yet accumulated on the surface of this organ in the early period of fœtal existence; but this is generally the case with all parts of the body.

The pericardium is then proportionally thicker than at subsequent periods, and its internal or reflected layer adheres less intimately to the heart.

C. SEXUAL DIFFERENCES.

§ 1315. The only sexual difference seen in the heart is that it is proportionally a little larger in males.

CHAPTER V.

MOTIONS OF THE HEART.

§ 1316. The circumstances in the history of the motions of the heart or in the heart in its active state, which deserve examination, are,

1st. The changes in its form.

2nd. The succession and simultaneousness of he motions in its different parts.

3rd. The relation between the cavities of the heart in its different states and the blood.

4th. The number of its motions.

5th. The changes in its situation.

6th. The duration of its motions.

7th. The conditions on which they depend.

§ 1317. 1st. The heart diminishes in contraction and enlarges in dilatation in every direction.*

2nd. The auricles and ventricles contract and dilate alternately, so that the two auricles and the two ventricles execute the same motions at the same time.† The auricles in contracting send the blood into

* *Sur le changement du figure de cœur dans le style*, in the *Mém. de Paris*, 1731, hist. p. 33, 40.

† The motions of the heart have been carefully analyzed by Laennec with the aid of the stethoscope, by which we can study them more correctly than by opening and inspecting living animals (*De l'auscultation médiate*, vol. ii. p. 195-227). From this analysis are deduced numerous important practical facts.

In the motions of the heart we must consider their extent, its impulse, the nature and intensity of the sound and the rythm, according to which the different parts of the organ contract.

1st. *Extent.* In a healthy and moderately fleshy subject, the pulsations of the heart are heard only in the space between the cartilages of the fifth and sixth true ribs, and under the lower part of the sternum. Those of the left cavities correspond principally to the first point, and those of the right to the second. If the sternum is short, we hear the pulsations in the epigastrium also. When the subject is so fat that they cannot be felt by the hand, the space in which they can be

the ventricles, which then contract on it, and throw it into the arteries at their base. A small quantity of the fluid however always returns from the arteries into the ventricles, from these into the auricles, and thence into the veins which open into them.

3rd. The cavities of the heart are almost entirely empty when they contract. However a little blood always remains, which is attached especially to the reticulated surface of their inner face.

4th. When the ventricles contract the apex of the heart beats against the anterior wall of the chest, notwithstanding that the organ shortens. This arises principally because that the auricles are then filled, both by the blood disgorged by the veins and by that which

heard by the stethoscope is sometimes only about a square inch. In thin persons, when the chest is narrow, and even in children, they always have more extent. They may be heard in the lower third, or even in the three lower fourths, of the sternum; sometimes also, under all this bone, at the left anterior and upper part of the chest to near the clavicle, and sometimes, but less manifestly, under the right clavicle. The subject rarely enjoys perfect health when the extent of the pulsations exceeds these limits, so that they are heard in the left side of the chest, from the axilla to the region corresponding to the stomach; and to a similar extent on the right side, at the left posterior part of the chest; finally, on the right posterior part, a successive progress, which would seem to be constant, and which is attended with a progressive diminution in the intensity of the sound. In this respect we may state as a principle, that the extent of the heart's pulsations is directly as the feebleness and the thinness of its parietes, especially those of the auricles, and inversely as their force and thickness.

2nd. *Impulse of the heart.* In contracting, the heart gives a sensation of percussion, raising or repelling the hand, or any other part placed upon the anterior walls of the thorax. In some individuals this impulse is visible, and sometimes causes a very extensive motion, which raises the parietes of the chest, the epigastric region, and even the clothing. It is however but slightly marked when the proportions of the heart are normal, and is often imperceptible in fat people. It is perceptible only during the systole of the ventricles. If the contraction of the auricles sometimes produces a similar phenomenon, it may be distinguished from the first, inasmuch as most generally it consists only in a kind of rumbling, which is heard very deeply in the mediastium. This impulse is generally perceptible only between the cartilages of the fifth and sixth true ribs, or, at most, in the lower half of the sternum, and in some subjects, when the sternum is very short, in the epigastrium. Generally speaking, it is inversely as the extent of the pulsations, and directly, as the thickness of the ventricles.

3rd. *Nature of the sound.* On listening attentively we distinguish during the pulsations of the heart two distinct sounds: one, duller and continued; the other, quicker, and more distinct. The first is simultaneous with the pulsations of the arteries and marks the contraction of the ventricles; the second is caused by the contractions of the auricles. That heard at the lower part of the sternum belongs to the right cavities; that distinguished between the cartilages of the fifth and sixth ribs depends on the left cavities. In the normal state, this noise is similar and equal on both sides; and is no where so loud as in the precordial region. It is as much stronger as the parietes of the ventricles are thinner, and as the power of impulse of the heart is less.

4th. *Rythm.* The duration of the sound caused by the auricles is shorter than of that produced by the ventricles; hence, the contractions of the auricles do not continue as long as those of the ventricles. There is a well marked but short interval of rest between these two sounds. This observation proves that the heart, like all other muscles, is alternately in a state of action and of rest. We may admit, that of the twenty-four hours, the ventricles have twelve and the auricles eighteen hours of rest; in supposing also that the cavities of the heart are entirely passive in their dilatation. In fact, Laennec admits that in the most general state of the whole duration of time in which the successive contractions of different parts of the heart, occur, a third at most, or even a quarter, is occupied by the systole of the auricles; a fourth, or a little less, by absolute rest, and a little more than a half by the systole of the ventricles. F. T.

flows back from the ventricles, so that the latter are pushed forward: but it depends also a little on the extension of the arterial trunks at the moment when the arterial blood which is sent from the ventricles passes through them.* From not attending to these last two circumstances it was for a long time impossible to explain the pulsations of the heart during its contractions, except by admitting that it lengthened in performing this motion, which is very improbable.

5th. The mean number of pulsations of the heart in the adult is seventy per minute. But it varies much according to the individual. The pulsations are generally more feeble and fewer in the female. If we except the early periods of life when the contractions of the heart are few, the number of its pulsations is much greater the nearer it is to the period of its formation.

6th. We generally consider the heart as that part in which irritability continues the longest. But it follows from the observations of Haller, Zimmerman, and Oeder, that there are exceptions to this law; and the observations of Fontana, Crève,† and Nysten, ‡ with which our own agree, demonstrate that this is not true, at least to the arterial portion, since the ventricles lose their irritability before the other muscular parts of the body; but the auricles preserve it the longest, ¶ and that the right auricle remains irritable longer than the left. Haller has attempted to prove that this latter difference depends on the circumstance that the right auricle is stimulated longer by the blood within it, || but we have often seen it in hearts which were removed from the chest and totally destitute of blood. Nysten has observed it also in persons who were beheaded. We then have reason to say it dedends on the greater tenacity of life in this part of the heart, and the more as the tenacity increases in animals in a direct ratio with the predominance of the venous system in them.

7th. The conditions of the action of the heart are the same as those of muscular action generally. For this then we refer to the details already mentioned in a previous part.

* When the ventricles contract, the point of the heart strikes the left lateral wall of the chest, between the cartilages of the fifth and sixth ribs. The two causes mentioned by the author, the filling of the auricles and the extension of the trunks of the arteries, doubtless contribute to produce this phenomenon; but we may admit also that while the ventricles contract, their moveable point rises, and performs the motion of a pendulum on the base of the heart, which, being more fixed, serves as a point of support.

† *Vom Metallreize*, Leipsic, 1796, p. 100,

‡ *Recherches de physiol. et de chimie*, Paris, 1811, p. 307.

¶ As Davy observed in experiments for another purpose. See his *Researches on nitrous oxide*, London, 1800, p. 352.

|| *De cordis motu a stimulo nato*, in the *Comm. Gott.*, vol. i.

CHAPTER VI.

OF THE HEART IN THE ABNORMAL STATE.

§ 1318. The anomalies of the heart are divided into two sections, according as they affect the form or the texture of this organ. We shall mention here only the first, having spoken of the latter in a previous part, when treating of the alterations in the texture of the vessels, of the muscles, and of the serous membranes.

§ 1319. The deviations in the formation of the heart embrace anomalies which may exist in number, situation, volume, and figure.

§ 1320. In regard to number, the heart may vary from the normal state in two opposite modes, that is, may be either wholly or partially deficient, or may have supernumerary parts.

The heart is entirely absent only when the upper half of the body is very imperfectly developed, and the head is then usually deficient. However, this rule presents but rarely exceptions of two kinds: for, first, the heart sometimes appears when the head does not exist; * and secondly, this organ is sometimes wholly† or partly deficient‡ in monsters where the trunk and head are not very much deformed. We shall speak of the partial absence of the heart hereafter.

The plurality of the heart, the body being simple, is infinitely more rare, however common it may be when the body is double, but is not seen constantly even in the latter case. We know of but one instance of a perfect plurality of the heart where the body was single. We are led to this anomaly by the fissure of the ventricles and by the congenital existence of abnormal and hollow appendages to the heart.§

§ 1321. The anomalies in the situation of the heart are congenital or accidental. In the first case the organ exists sometimes within, and sometimes outside of the cavity of the thorax.

When found in the chest it may be,

1st. Straight, and then either perpendicular, or horizontal, or finally placed so that its summit looks upward. ‖

2nd. Reversed, having its base to the left and its summit to the right, an anomaly which exists singly or which is attended with the more or less perfect inversion of the other organs.¶

* We have collected all the instances of this anomaly in our *Handbuch der pathologischen Anatomie*, vol. i. p. 165.

† See our *Handbuch der path. Anat.*, vol. i. p. 414. Besides the cases there mentioned, two have been published since; one by Brodie (*Phil. Trans.* 1811), and the other by Lawrence (*Med. Chir. Trans.*), vol. v.

‡ Ruderer, in the *Comment. Gott.*, vol. iv.—Meckel, *Handb. der path. Anat.*, vol. i. p. 421.

§ We have collected all the cases of this anomaly in Meckel, *De duplic. monstrosâ*, p. 53. and *Handb. der path. Anat.*, vol. ii. p. 33-45.

‖ Meckel, *Handb. der path. Anat.*, vol. i. p. 418.—Bertin in his work has figured a heart which was situated transversely in the cavity of the thorax.

¶ One case of this kind now before us has been figured in Meckel, *De conditionibus cordis abnorm.*, Halle, 1802, vol. i.

3rd. Deeper than usual.*

When it exists out of the chest two cases are possible.

1st. The anomaly being slight the heart hangs loosely outward, either in its usual place† or higher than it is generally, in the cervical region.‡ In this case the pericardium is usually but not always deficient. On the other hand it sometimes but very rarely happens that this membrane is not found even when the heart is situated in the chest, and then it is replaced by the pleura.§

2nd. The anomaly existing in a greater degree which is also still more rare, the heart is found in the abdomen,‖ a deviation of formation to which the very sloping situation of this organ in the pectoral cavity leads.

The accidental anomalies in the situation of the heart depend on the accumulation of solids or liquids within the chest or the penetration of foreign bodies there, and follow no constant and fixed laws.

§ 1322. Anomalies in the volume of the heart are congenital much less frequently than accidental. They however sometimes have the character of a primitive formation, and are even hereditary in many families. The heart is then too small or too large. We often find both of these anomalies in the different parts of the same heart.

The smallness of the heart¶ is much more rare than its excess in volume. It is often carried to an extreme point although the formation of the organ is unchanged.**

As to the excessive size of the heart, we must distinguish the pure and simple increase in its mass, the thickening of its parietes,†† from the thickening of its parietes with an increase in its capacity,‡‡ and from its simple dilatation or an increase in its capacity§§ with or without a thinness of its parietes, since we find all these states sometimes

* Meckel, *Handb. der. path.Anat.*, vol. i. p. 417.

† *Id. Ibid.* vol. i. p. 406.

‡ *Id. Ibid.* vol. i. p. 98, 99.

§ See our *Handb. der path. Anat.*, vol. i. p. 110.

‖ Deschamps has mentioned an instance of this in Sedillot, *Recueil périodique*, vol. xxvi. p. 275-279.

¶ We have mentioned several cases in our *Handb. der path. Anatomie*, vol. i. p. 470-472.

** Consult also, on the wasting of the heart, Laennec (*De l'ause. Méd.* vol. ii p. 291), and Bertin (*Des mal. du cœur*, p. 387). The latter admits two kinds; one where the walls of the heart are collapsed, the other where the same parietes, especially those of the ventricles, are, on the contrary, dilated, and at the same time become thinner; this is the state termed passive aneurism. F. T.

†† Different instances of the simple increase of the mass of the heart have been reported by Vetter, *Aphorismen aus der pathologischen Anatomie*, p. 99.—Legallois, in the *Bullet. de l'Ec. de Méd.*, 1813, 1814, p. 69.—Morgagni, *Ep. anat. med.*, 30 to 20—Burns.

‡‡ We find several cases of it in Morgagni, *Epist. anat.* 18 to 28, and 30.—Corvisart, *Malad. du cœur*, p. 91.

§§ Many instances of this anomaly are mentioned in Burns.—Morgagni, *Epist. anat.*, 18 to 2, and 14.—Dundas, *On a peculiar disease of the heart*, in the *Med. surg. Trans.*, vol. i. p. 37.

insulated and sometimes united.* The last two are termed *aneurisms of the heart*, which in the first case is called *active*, and *passive* in the second. The active aneurism is more common on the left side and the passive on the right. These two states usually coexist, the left side being dilated actively, and the right side passively, to a greater or less degree.† Sometimes the parietes of the left side have only become thicker, and those of the right side are on the contrary thinner, with or without dilatation at the same time.‡ However it often happens that one part or the other is diseased, each in its

* This distinction neglected by Corvisart who understands by the terms *active aneurism* and *passive aneurism* only a dilation of the heart with a *thickening* or *thinness* of its parietes, was made by Bertin in 1811, in a memoir presented to the Institute. Bertin admits three distinct *forms of hypertrophy* of the heart, that is, of its total or partial fleshy thickening: 1st, *simple hypertrophy*, in which the cavities of the organ preserve their natural capacity, at the same time that the parietes are more or less thickened: 2nd. *aneurismal hypertrophy*, in which the cavities are dilated and the parietes are thickened; this is the *active aneurism* of Corvisart: 3rd, *concentric hypertrophy*, in which the thickening of the parietes is attended with a greater or less contraction of the cavities. He also distinguishes two kinds of *aneurismal hypertrophy*; one in which the parietes are thickened, and the other where the parietes preserve their natural thickness, so that the increase takes place in some measure according to the extent and the circumference, or according to the surface. He has also remarked, that in the hypertrophy of the ventricles the thickness often diminishes from the base to the point, but it is sometimes about the same at the point as at the base, and in some cases is more marked in its centre, and diminishes toward the point and even toward the base. It may be equal to fifteen lines, and more, although Laennec asserts that it never exceeds four or five lines. Sometimes we find in the same ventricles one portion which is dilated and thickened, and another contracted and thickened, or one part thin, while the other is thick. We sometimes observe a great difference between the parietes of the ventricles, especially on the right side, and the fleshy pillars, the latter being doubled or tripled in extent, while the parietes are not, or but very slightly, thickened. In other cases, the hypertrophy of the left ventricle seems to take place at the expense of the pillars, which are effaced or are hardly visible. The hypertrophy of the left ventricle is generally attended with that of the septum. We sometimes observe also a hypertrophy of the interventricular septum only. The fleshy pillars of the right ventricle have been found so thickened and intercrossed that there was hardly any cavity. Hypertrophy also often affects both ventricles at once, but not unfrequently they present an opposite state. The point of the thickened ventricle always descends lower than that of the other. The three forms of hypertrophy are observed in the auricles, but the aneurismal is the most common. The thickening is nearly equal in all the extent of the parietes, especially in the left auricle. The muscular fasciculi of the right auricle sometimes increase in volume. Finally, in certain cases, the parietes of this auricle are so much thickened in all their parts, that they imitate those of the corresponding ventricle. Again, whatever may be the form of the hypertrophy, Bertin admits, as its immediate and proximate cause, an irritation applied to the heart, which increases the activity of the phenomena of nutrition in this organ (*Des maladies du cœur*, p. 282). He admits also three kinds of dilatation of the heart, or to proper aneurism: 1st, dilatation, with thickening of the parietes, or *aneurismal hypertrophy*; 2nd, dilatation, with thinness of the parietes; the *passive aneurism* of Corvisart, which is more rare than the preceding; 3rd, dilatation of the cavities, they being of their usual thickness, or simple dilatation, which has not hitherto been regarded. To these three classes he adds a fourth, which is doubtful; the mixed dilatation, in which the parietes of the dilated cavity are thicker in some parts and thinner in others, and of their natural thickness in the rest. (*Ibid.* p. 368.) Consult also, on hypertrophy of the heart, Lallemand, *Observations pour servir à l'histoire des hypersarcoses du cœur*, in the *Archiv. gen. de méd.* vol. v. p. 520. F. T.

† Morgagni, *Ep. anat.* an. m. 10 to 23.—Testa, *Mal. del. cuore*, iii. c. xv.

‡ Morgagni, *Ep. anat*, m. 30 to 20.

usual manner.* The disease does not necessarily effect an entire half. Generally, passive aneurism exists only in the right auricle, and active aneurism only in the left ventricle, whether these two states exist alone, or whether they are both found in the same heart. Sometimes however, but rarely, the right side is entirely or partially thicker than usual, or at the same time dilated; and then sometimes the left side is also affected and sometimes it is not: sometimes also it presents a passive aneurism, or at least its walls have become thinner. Perhaps the passive aneurism is still more rarely confined to the left ventricle, while all the other parts of the heart are in the normal state.†

These affections are confined to one part of the heart only, much more generally than they are extended to the whole of it. Nevertheless, if we except the active aneurism of the left side, combined with the passive aneurism of the right side, which is frequently observed, we sometimes find hearts which are affected equally in every part.‡

The diseased cavity of the heart is most generally dilated in its whole extent. A partial dilatation in the form of a cul-de-sac rarely exists.

The substance of the heart is sometimes, but very rarely, thicker in some parts from round excrescences which project on its internal face. We know of but one instance of this arrangement, and the specimen is in our cabinet. This is still more curious, as it throws much light on the formation of the polypi of the heart, which are explained with difficulty unless we admit that one or more of these excrescences are detached from their place of origin.§

§ 1323. The anomalies in the form of the heart relate either to its external or to its internal arrangement, or finally to both.

They are congenital much oftener than accidental.

§ 1324. The congenital anomalies in the external form are :—

* We find instances of the active aneurism of the left ventricle in Lancisi, *De rep. mort.*, p. 137.—Lafaye, in the *Mém. de Paris*, hist., p. 29.—Corvisart, *Journ. de med.* vol. xi. p. 257.—We find cases of the passive aneurism of the right ventricle only in Fleury, *Bull. de l'Ec. de méd.*, 1807, p. 124.—Morgagni, *Epist. anat.*, m. 18 to 6.

† We find one case in Corvisart, p. 99.

‡ Different cases which prove this proposition, both in respect to the simple thickening of the parietes, and also to passive aneurism, are mentioned in Vetter, *loc. cit.*, p, 99.—Burns.—Morgagni, *Ep. anat.*, m. 18 to 2, 28, 30, ep. 53 to 9.—Corvisart, p. 61, 87.—Testa, *loc. cit.*, vol. iii. ch. xvi. n. 7, 8. p. 361-367.

§ Laennec relates several cases of this abnormal arrangement (*De l'auscultation* visart, Testa, Burns, Creysig, and Laennec, that *polypi*, or rather *fibrinous concremediate*, vol. ii. p. 344) which he terms *globular excrescences* of the heart, and which he compares to the excrescences of the valves. Meckel's mode of explaining them cannot be maintained. Bertin (*loc. cit.*, p. 444) not only admits with Cor*tions*, may form, during life, in the heart, as in all other portions of the sanguineous system; but he also adopts Creysig's theory, and regards them as resulting from an effusion, which occurs after inflammation of the inner membrane of the heart. These concretions are most generally free from all adhesions, at least organic: but sometimes also they are perfectly organized, and have numerous vessels injected in bright red or black. This important fact, of which Bouillaud has

1st. The form of the *heart* is more rounded; this is sometimes met with alone, but is usually attended with several other anomalies already mentioned, or which remain to be described, as prolapsus, perpendicular position, &c.

2nd. The deep fissure of the summit of the heart, to which our remarks on the preceding anomaly apply.

The accidental anomalies in the external formation are principally the *solutions of continuity*, which must not be confounded with those which are congenital, for the latter implicate the inner form, and they consist essentially in anomalies of the connection of the two portions of the heart.

Solutions in continuity of the heart are *fissures* or *wounds*.

*Fissures** occur most generally after those pathological changes which supervene in the substance of the heart itself, or in the arterial trunks. They less commonly depend on external injuries, which do not directly affect the substance of the heart, but act either on the parietes of the thoracic cavity, or on the organs within it.

1st. The changes in the substance of the heart giving rise to fissures, are produced principally by *inflammation*, *ulceration*, and *gangrene*,† which soften this substance,‡ and gradually destroy it in one or more parts, so that there is finally a solution of continuity during the systole or the diastole. One can imagine that this species of fissures is equally frequent in all parts of the heart.

2nd. Those on the contrary which depend on morbid changes supervening in the arterial trunks occur in some points more frequently than in others, and are probably more common in one sex than in the other.

published two remarkable instances (*Obs. et cons. nouv. sur l'oblitér des veines*, in the *Arch. gén. de méd.*, vol. v. p. 95, and 101), throws great light on the theory of the formation of polypi of the heart, inasmuch as we can no longer doubt that their organization takes place in the same manner as that of the false membranes, and depends on the same cause F. T.

* Bland, *Mémoir sur le déchirement sénile du cœur*, in the *Bibliothèque médicale*, vol. lxviii, p. 361.—Rostan, *Mémoires sur les ruptures du cœur* in the *Nouveau Journal de médicine*, vol. viii. p. 265.—A. J. L. Bayle, *Observation de rupture du cœur*, in the *Revue médicale*, vol. iii. p. 96,—Carrier, *Observation sur une double rupture des parois du ventricule gauche du cœur*, in the *Journ. univ. des sc. médicales*, vol. xxxv. p. 358.

† Although, strictly speaking, gangrene of the heart is not impossible, it is at least so rare that those observers in whom the fullest confidence can be placed have not seen it. Thus Corvisart does not hesitate to say that no well authenticated case of it exists. Most of the facts which have been reported, being stated in a faithless manner, should be received only after strict examination and admitted with distrust. Such is the very wise opinion of Bertin (*Des malad. du cœur*,, p. 408), who thinks that these facts should be considered as acute softenings of the heart rather than real gangrenous affections. F. T.

‡ Laennec first called the attention of pathologists to softening of the heart, of which he admits two species, one where the substance of the organ is more deeply coloured, the other where it is discoloured, or rather has a whitish or yellowish tinge (*De l'auscultation*, vol. ii. p. 186). He asserts that he has found this softening in all cases of fever called *essential*, when he has attended to them. He does not however consider this as a character of inflammation. Bertin thinks it is caused by inflammation of the heart, which is acute when it is of a deep red or even brownish, and chronic, when the muscular tissue of the organ is discoloured and becomes pale or yellowish. F. T.

Thus the part of the heart most frequently ruptured is the left ventricle, and this accident is more common in the male than in the female, because the ossification of the valves and the contraction of the arterial orifice, which is a consequence of it, are observed in the left more frequently than in the right, and in the male oftener than in the female. When this occurs, the substance of the heart is thinner less frequently than it is thickened and hardened.

The normal difference between the right and left portions of the heart also accounts for the greater frequency of the fissures on the left side, since the right side is less tense and more extensive than the other.

The normal arrangement of the heart explains also why fissures occur in one part of the ventricles rather than in another.

This point is commonly the place where the arterial trunk unites to the ventricle,* because there is no continuity in this place between the fibres of the heart and those of the arteries.

The place where fissures occur most frequently, next to this, is the apex of the heart, as there the substance of the organ is thinnest.

Contusions of the chest or the forcible penetration of foreign bodies, as of musket-balls, also tear the heart, even when the parts surrounding this viscus are uninjured.

Besides these fissures, which are visible externally and which pass through the heart entirely, there are others which are much less frequent, and where either the tendons of the venous valves or the fleshy pillars are detached from their points of insertion. The latter almost always result from violent efforts or emotions.†

Wounds of the heart are or are not attended with the presence of the wounding body. In both cases they pass through all the substance of the organ or affect only its surface. Wounds attended with the presence of the foreign body are seen principally after musket-wounds, when the ball, not having power enough to pass through the heart, remains within it or probably insinuates itself by degrees, the wound cicatrizing behind it as it advances. In both these cases the individual has sometimes survived so severe an injury, but this is rare.‡

Penetrating, cutting, or pricking wounds are always and almost

* This assertion is not correct. Ruptures of the heart occur always, or most generally, toward the apex and the anterior part, that is, in thet hinnest part. In this respect, Rostan has observed that the disproportion of the diameter is such, that often, when the diameter of the upper part of the ventricle is sixteen or eighteen lines, which he asserts is the greatest development which it can attain, the apex is only two lines thick. Bayle has mentioned, that of nineteen instances of rupture of the heart, fourteen existed in the left ventricle, principally its anterior face near the apex, three in the right ventricle, one in the apex, and the other in the interventricular septum. In most of the cadavers the heart was remarkably soft, and in some cases a brownish colour was observed around the perforation. These two circumstances support Bertin's opinion, who (*Des maladies du cœur*) thinks that the preceding erosive inflammation plays an important part in these perforations, as in those of the stomach and intestines. F. T.

† Corvisart, *loc. cit*, p. 256, *De la rupture partielle du cœur*.

‡ We find an instance of the first case in the *Dict. des sc. méd.* vol. iv. p. 217, and one of the second in Penada, *Saggi sc. di Padova*, vol. iii. part 2. p. 59.

immediately mortal.* In order to conceive of a contrary case, we must admit that the wounding instrument penetrates gradually.†

§ 1325. Most of the deviations in form in the inner parts of the heart are congenital. They comprise, 1st, those which cause no derangement except in the circulation of the blood; 2nd, those which derange the formation of the blood.

§ 1326. The deviations of form in the first class consist principally in the abnormal arrangement of the several orifices of the heart.

Among these are:

1st. *The abnormal narrowness of the venous orifices of the ventricles.*‡ This anomaly occurs most frequently on the left side, and is not rare. The mitral valve is then always thickened, more or less hardened, and often ossified. It is very doubtful if this anomaly ever be congenital. At least it is not so generally.

2nd. *The abnormal narrowness of the arterial orifices of the ventricles.* This congenital aberration occurs most frequently on the right side, and almost always results from a contraction, often also from an adhesion of the valves.

* Wounds of the heart are generally mortal after a few moments, or at most some hours. Some wounded persons have been known to survive one or five, seven, thirteen, seventeen, and twenty days, after penetrating wounds. See the surgical part of the article *Cœur*, by Begin, in the *Diction. abrégé des sc. médic.*, vol iv. p. 493. F. T.

† Although it did not form a part of our author's plan to speak of the alterations in the texture of the heart, we think it necessary to say a word upon its hardening, the theory of which appears to be intimately connected with that of its hypertrophy, its polypi, and its softening, that is with its irritation more or less approaching to the degree usually considered as inflammation. General hardening of the heart has not yet been noticed; but it may be more or less extensive and sometimes invade an entire half of the heart. It is often confined to the internal or external face, where it is presented under the form of incrustations. The fleshy columns and the septum may also be the exclusive seat of it. It presents several degrees. Simple hypertrophy is the first and ossification the last. There are different shades between these two extremes; sometimes the substance of the heart, of a bright red colour and almost healthy in appearance, resembles in hardness a fibro-cartilage, and gritsts or grates when cut: sometimes it presents a cartilaginous density and solidity; again it it still harder and sounds like horn, as Corvisart says; sometimes it resembles earth or sand (Bertin, *Des mal. du cœur*, p. 401). Ossifications of the heart are not rare in man. Meckel has collected several instances in his *Dissertatio de cordis conditionibus abnormibus*, Halle, 1802, and in his *Manual of Pathological Anatomy*. It is curious that in many animals, especially in the ruminantia, there is very often a bone in the heart. This has long been known in regard to the ox and the stag. See on this subject Keuchen, *Diss. de ossiculis e cordibus animalium*, Groningen, 1772.—Jaeger, *Ueber des Vorkommen eines Knochen im Herze des Hirsches*; in the *Deutsches Archiv fur die Physiologie*, vol. v. p. 113.—F. S. Leuckart, *Bemerkungen über den Herzknochen des Hirsches*; same journal, vol. vi. p. 139.—We think it worthy of mention, however, that Lecuyer has found 1,7 of phosphoric acid, 2 of uric acid, 3 of animal matter, 5,3 of lime, in twelve grains of the ivory substance coming from the ossification of the valves of the heart, from its external face at the base of the right ventricle, and from the aorta, and also from the large branches which arise from it (*Journal de la société des sciences, agriculture, et arts, de Strasbourg*, 1824, No. 3). The presence of uric acid in this case is remarkable as an analogy with what is seen in arthritic concretions. F. T.

‡ Abernethy. *On a diminution in consequence of disease of the area of the aperture, by which the left auricle of the heart communicates with the ventricle of the same*; in the *Med. chir. trans.* vol. i. p. 27.

3rd. *The deficiency or adhesion of the valves,* especially those of the arteries, sometimes occurs, and is not generally congenital but accidental. The absence of the valves is caused by their destruction by suppuration, and their adhesion results from inflammation and ossification.

4th. *An excess or deficiency in the number of the valves,* which is seen particularly, but yet seldom, in the pulmonary artery, and much less frequently in the aorta. We find four valves more commonly than two.

§ 1327. The essence of the deviations in form of the second division is an abnormal communication between the systems of red and black blood. They have no influence on the formation of blood, or when they possess it, the arrangement is such that the black blood becomes less venous or the red blood less arterial. In both cases the abnormal union of both the systems of blood may take place in very different parts.

1st. The abnormal communication of the first kind depends,

a. On the insertion of one, of several, or of all the pulmonary veins in the vena cava superior. We have a case of this kind before us.

b. On the existence of an accessory pulmonary artery, which arises from the ascending aorta.*

2nd. The abnormal communications of the second kind occur either between the auricles, or the ventricles, or in the large vascular trunks. Many or all these anomalies are not unfrequently combined in the same subject.†

a. The most simple form is a single heart, consisting of one muscular cavity.

b. Next follows the formation where only one auricle and one ventricle exist, whence a single vessel, the aorta, arises, from which the pulmonary artery branches off, while the pulmonary veins open into the auricle, or even, by a formation still more abnormal, into the vena cava superior.

The formation is more perfect when the heart is divided by a septum into two halves, and the aorta and the pulmonary artery arise by separate trunks, but the septum is imperfect.

c. In this case the septum of the ventricles and of the auricles is perforated and the foramen ovale is open, which is the case most frequently; or,

d. Only the septum between the ventricles is perforated, a more unfrequent formation; or

e. Only the foramen ovale is open; this is the most usual.

* We have collected all the known cases of this anomaly, in the *De monstrosâ duplicitate*, p. 55, and in *Handb. der pathol. Anat.*, vol. ii. p. 134.

† The different degrees and in general most of the species of this class of anomalies are described in our *Handbuch der pathol. Anat.*, vol. i. p. 422-470, vol. ii., p. 133, 134.—Farre, *Pathological researches, Essay* 1, *On malformations of the human heart*, London, 1814.—J. C. Hein, *De cordis deformationibus quæ sanguinem venosum cum arterioso misceri permittunt*, Gottingen, 1816.

The septum of the ventricles is perforated generally in one determinate place, viz. the base ; so that sometimes the aorta, sometimes but more unfrequently the pulmonary artery, arises from both ventricles ; in the latter case the aorta arises as usual, but forms only an ascending portion, and terminates in the left subclavian artery, and the descending aorta comes entirely from the pulmonary artery.

The interauricular septum is frequently developed imperfectly, that is, its formation has not followed the course mentioned above (§ 1305), but the pressure of the left auricle can then complete it; so that the passage of the blood from this auricle into the right becomes impossible. Sometimes however, but more unfrequently, from the absolute or relative smallness or deficiency of the valve of the foramen ovale, this opening is so large, that the right and left auricles communicate freely. This continuance of the foramen ovale is more unfrequent than the perforation of the septum, although its imperfect closure, produced in the manner stated above (§ 1305), is an anomaly still more frequent than this.

The abnormal arrangements of the large vascular trunks, which render the hematosis imperfect, are,

f. The obliteration or the considerable contraction or deficiency of the pulmonary artery, states which commonly but not always attend one of the anomalies mentioned above.

g. The continuance of the arterial canal, which seldom occurs alone, but is generally attended with one of the anomalies already described or which remain to be mentioned.

h. The existence of a second pulmonary artery, which arises from the right ventricle and terminates in the aorta. Finally,

The transposition of the origins of the arterial or venous trunks, viz.

i. The origin of the pulmonary artery from the left and of the aorta from the right ventricle, while the venous trunks empty themselves in their proper places.*

k. The insertion of the veins of the body into the left portion of the heart, or into the pulmonary veins, or frequently into the pulmonary artery. This occurs in different ways. We have before us a preparation where the large coronary vein of the heart, instead of terminating in the right portion, opens into the left auricle of the heart. In another case, the vena azygos is divided near the heart into two branches, one of which goes to the right, the other to the left auricle. Sometimes the pulmonary arteries evidently anastomose with the azygos vein.

The physiological influence and importance of these anomalies are not the same.

In the first point of view, we may state it as a principle, that the first six arise because the formation of the heart is arrested at an early period of development, and because it is a repetition of the formation of

* Tiedmann has described and figured a case of this anomaly in the *Zeitschrift fur Physiologie*, ch. i. p. 111, pl. 7, fig. 9.

the heart in some of the lower classes of animals, particularly the crustaceous animals, the mollusca, and the reptiles. The others are normal in no period of life, but belong to the class of anomalies which affect the quality of the organs.

Hence also why the former are more frequent. The influence on the hematosis is much more injurious, the greater the mixture of the black and red blood: it is very slight either when the abnormal communication is merely by the small vessels (*k*), or when the communication is interrupted by the arrangement of the parts at the moment when it might be injurious: this occurs in most cases where the foramen ovale becomes open. The derangement is very great in other cases.

The effects which result from them are, frequent recurrence of asthma, extreme weakness of the voluntary muscles, great debility in the nervous system, often a defect in nutrition and development, and a blue colour of the body. Death usually supervenes in the early periods of life, although in a few rare cases the patient has lived till the age of fourteen. At certain periods, especially during dentition and at the age of puberty, the symptoms recur more frequently and with greater violence. The cause of these symptoms and the essence of the derangement is, the mixture of venous with arterial blood and the distribution of this mixed blood in the body; they arise sometimes, as for instance when the pulmonary artery is entirely closed or does not exist, or when the pulmonary artery arises from the left ventricle and the aorta from the right ventricle, because the organs of the body receive pure venous blood.

From the blue colour of the skin, which depends upon the venous blood not being changed into arterial blood,* this disease has been termed *cyanopathia* (*morbus cœrulous, cyanopathia, cyanosis*).†

* Bertin has very properly remarked that this explanation cannot be admitted, for three reasons: 1st, because cyanosis did not exist in cases where the right and left heart communicated; 2nd, because it did exist in other cases where this communication did exist; 3rd, because that if the blue colour of the skin was produced by this deviation of formation, it ought to exist also in other parts, which is not the case. Besides, as Fouquier justly remarks, the skin of the fœtus, in which only black blood circulates, is not blueish. Bertin thinks then that the blueish colour of certain parts, in different individuals where the two hearts communicated, depends on the stagnation of the blood in the right cavity and in the venous system, which is in a manner gorged with it; this explanation seems more rational, inasmuch as this anomaly in the formation of the heart is often attended with a contraction of the orifices or of the pulmonary arteries. F. T.

† Kwiatkowski, *Diss. aetiologiam morbi cærulei amplificans.* Wilna, 1816,—Hein, *Diss. de istis cordis deformationibus quæsanguinem venosum cum arterioso misceri permittunt*, Gottingen, 1816.- J. F. Meckel, *Essai sur les vices de conformation du cœur qui s'opposent à la formation du sang rouge*; in the *Journ. complém. des sc. méd.*, vol. iii. p. 224-501.—Gintrac, *Observations et recherches sur la cyanose, ou maladie bleue*, Paris, 1821.—Louis. *Observations suivies de quelques considerations sur la communication des cavités droites avec les cavités gauches du cœur*; in the *Archives générales de medecine*, vol. iii. p. 325, 485.

SECTION II.

ARTERIES OF THE BODY OR OF THE SYSTEM OF THE AORTA.

CHAPTER I.

GENERAL EXPLANATION OF THE SITUATION OF THE TRUNK.

§ 1328. The aorta arises most generally and with but few exceptions by one single stem from the upper part of the left ventricle. At its origin the fibrous membrane is much thinner than in the rest of its extent; but it is not entirely destitute of this membrane, the thinness of which is supplied by the muscular fibres of the heart, which extend some lines over the valves of the aorta, and the triangular spaces which exist between them. At its base are three sinuses, which correspond to the valves. It goes to the right, first its right side, and then the whole artery passing behind the pulmonary artery, which covers its origin: it comes afterwards on the right side of this artery, and describes a curve before the vertebral column, which is called its *arch* (*arcus aortæ*). The transverse portion of this arch, the part between the right and left sides, is situated opposite the third and fourth dorsal vertebræ.

At the origin of the arch the aorta is entirly enclosed in the pericardium; but it gradually leaves this membranous sac; so that most of the arch is entirely loose. We observe on the left the pulmonary artery, which proceeds along the lower part of the arch of the aorta, behind it the right branch of this artery, on the right the vena cava superior, and in front the sternum.

In old age, the lower and ascending part of the arch of the aorta is more or less dilated: it does not form a perfect cylinder; but it advances farther and projects more to the right than in early life. This change probably depends on a mechanical cause,—the continual impulse of the blood.

The central part of the arch of the aorta is situated before the lower extremity of the trachea, and the curve terminates behind the left branch of the pulmonary artery and the bronchia of the same side, in which place the direction of the artery changes and proceeds from above downward.

The ascending part of the arch is situated on the right of the vertebral column, the transverse portion directly before it and the descending portion on the left: the latter is situated in the posterior mediastinum.

The trunk of the aorta remains on the left of the vertebral column in all its extent.

The *ascending* portion of the aorta in the cavity of the thorax, called the *thoracic aorta* (*aorta thoracica*), is directly covered on the left by the inner wall of the left pleura, on the right by the esophagus, and forward first by the left bronchia, then by the posterior part of the pericardium.

At the diaphragm the aorta separates from the esophagus behind, passes through a special opening in this muscle (*hiatus aorticus*) (§ 1072), comes into the abdomen, and is called the *abdominal aorta* (*aorta abdominalis*). The latter descends as far as the fourth or fifth lumbar vertebra, where it divides into two branches. It is attended on the right by the vena cava inferior, rests behind on the lumbar vertebræ, and is covered both before and on the left by the peritoneum.

Above and below, it divides in an analogous but not in the same manner, since it gives off, 1st, at its two extremities, the vessels which go to the extremities; 2nd, and besides, at the upper extremity, the carotid arteries; 3rd, at the lower extremity those which supply the pelvic viscera with blood.

The vessels of the thoracic and abdominal viscera, and most of those which are distributed to the parieties of the thorax and abdomen, arise directly from the part between its two extremities.

That part of the aorta between its origin from the heart and that of the left subclavian artery (§ 1335), is called the *ascending aorta* (*aorta ascendens*), the remaining, the *descending aorta* (*aorta descendens*).

§ 1329. The aorta rarely varies from this general arrangement. Nevertheless it may, in the following modes:*

1st. The slightest aberration is when the aorta goes backward too soon, passing immediately on the right bronchia.

Then it sometimes reaches the left side, gliding behind the esophagus and the trachea, as we have observed;† sometimes it remains on the right in a greater or less extent of the vertebral column, for instance, to the base of the chest.

This anomaly may be considered as the first degree of the lateral inversion of the aorta, in which its arch curves more or less from left to right instead of describing its usual curve from right to left.

The arteries which arise from it are also modified in a similar manner; for we sometimes find four trunks; sometimes an innominata trunk exists on the left side and two other trunks on the right.

2nd. The anomaly is greater when the trunk of the aorta tends to divide. This deviation of formation presents several degrees.

* O. Bernard, *Diss. de arteriarum e corde prodeuntium aberrationibus*, Berlin, 1818.

† This anomaly has been seen also by Abernethy (*Phil. trans.*, 1793, p. 59-63), and twice by Caillot (*Bullet. de l'Ec. de Med.*, 1807, p. 21-28).

a. Sometimes the aorta is single at its origin; but, some inches farther, it divides into two trunks, which pass one before, the other behind, the trachea, and afterwards unite to give rise to the descending aorta, forming in this manner a ring around the air passage. Hommell has described a curious case of this kind.

b. A greater degree of this deviation of formation exists as in the case reported by Malacarne.* In fact the aorta is single at its origin; but from this point even, its increased size, its oval form, and its five valves, indicate a division which occurs almost immediately. The two branches on the right and on the left give off, first the subclavian, then the external carotid, and finally the internal carotid artery; they remain distinct from each other for about four inches, and then they unite to form the descending aorta.

This division of the largest artery of the body is curious in this respect, that it is evidently a repetition of the formation of reptiles, a class of animals in the different orders of which these anomalies constitute the normal state. It leads also to the third kind of anomaly.

3rd. In this species of anomaly there is no arch. The aorta divides at its origin into two trunks, one right and ascending, which produces the subclavian and carotid arteries; the other descends and is the pectoral and abdominal aorta.†

§ 1330. The aorta presents anomalies not only at its origin, but also in the rest of its course. Thus, the lower extremity of the arch is sometimes very much contracted‡ or entirely closed§ in a slight extent; and although the artery does not divide in this place into two large trunks, the circulation however continues by collateral vessels, which are very much enlarged.

Similar anomalies are observed also, but less frequently, in the lower part of the aorta. Thus sometimes the artery bifurcates higher than usual, to give rise to the primitive iliac arteries, which, before they divide into two large trunks, communicate by a transverse branch.‖

CHAPTER II.

ARCH OF THE AORTA.

§ 1331. From the arch of the aorta, or from the ascending aorta, arise first, the coronary arteries of the heart; next at a certain distance from them, the arteries of the upper extremities and of the head, which come from its upper and transverse part.

* *Osserv. di chirurgia*, vol. ii p. 119, tab. i. f. 1, 2.—*Auctuarium obs. et icon. ad osteol.* Padua, 1801, tab. iii.

† *Abhandlungen der Joseph. Akademie*, p. i. tab. vi.

‡ Paris, in Desault, *Journ. de. chir.*, vol. ii. p. 107, 110.

§ Stoldele, *Sammlung chirurgischer Beobachtungen*, vol. ii. p. 114, 116.—Graham, in the *Med. chir. trans.*, vol. v. no xx.—Cooper, in Farre, *loc. cit.*, p. 14.

‖ Petsche, *Syllog. obs. anat. select.*, § 77.

ARTICLE FIRST.

I. CORONARY ARTERIES OF THE HEART.

§ 1332. The *coronary* arteries (*A. coronariæ, cardiacæ*) arise directly above the origin of the aorta, and normally above the upper edge of the semilunar valves, so that their orifices, which correspond to the central part of these valves, are not closed when these valves are pressed against the parieties of the aorta. There are usually two, and not unfrequently three ; the third, which is generally smaller than the others, then arises, not above a special valve, but above and very near one of those to which the other two correspond. We once have found four coronary arteries, of which the two supernumerary arteries were much smaller than the others, and only branches prematurely detached from them.

A single coronary artery is much more rare. We have seen this anomaly which however is indicated by the less distance between the origins of the two arteries in some subjects, or in the extreme smallness of one of these vessels, the branches of which are entirely replaced by those of the other.* The existence of one coronary artery is curious, as it establishes a relation with the normal formation of the elephant.

But however this may be, each ventricle has a coronary artery which almost exactly corresponds to it.

§ 1333. The *right, upper*, or *anterior coronary* artery (*A. coronaria anterior*, s. *inferior*, s. *dextra*) is generally but a very little larger and rarely smaller than the left. It arises from the anterior part of the aorta, above the anterior valve, passes under the pulmonary artery, between the upper part of the right ventricle and the right auricle, being covered by the latter, goes forward to the right, and downward in the groove at the base of the heart, turns around the pulmonary auricle, and thus arrives at the lower face of the heart, and terminates in the inferior groove of its septum.

In its course it gives off at right angles, both on the right and left sides, several branches, which are often very much curved.

The right branches are smaller, and are distributed to the right auricle ; the left, which are larger, go to the right ventricle, and descend longitudinally on its surface to its apex.

The longest of these descends in the inferior groove of the septum, where it anastomoses by several branches with the left coronary artery.

Other ramifications always exist, which are smaller, and are distributed on the anterior part of the left ventricle, and also commu-

* Barclay (*loc. cit.*, p. 6) has seen the right coronary artery so small that it did not extend to the left as far as the septum, and was replaced on this side by the transverse branch of the left coronary artery.

nicate with those of the left coronary artery on the flat side of the heart.

This artery belongs principally to the right half of the heart.

§ 1334. The *left, upper*, or *posterior coronary* artery (*A. coronaria sinistra*, s. *superior*, s. *posterior*) is generally smaller than the preceding, and arises between the left auricle and the posterior side of the pulmonary artery, almost always above the left sigmoid valve. It descends on the left, between the auricle and the pulmonary artery, and, having attained the groove at the base of the heart, divides into two or three larger branches.

Of these one, which is anterior and longitudinal, soon separates into several considerable branches, and descends along the upper groove of the septum to the apex of the heart. In its whole course it gives off branches which anastomose with those of the right coronary artery on the upper face of the right ventricle. Some of the large branches which come from it are distributed on the upper face of the left ventricle.

The second branch, which is transverse, goes backward in the groove at the base of the heart, below the left auricle, and gives off several branches, which go to the upper face of the left ventricle. The largest descend along the smooth posterior edge of the heart, some on its upper and others on its lower face.

Finally, the left coronary artery terminates by several small branches, which disappear on the lower face of the left ventricle.

These ramifications, like the preceding, anastomose with the other branches of the left coronary artery and with those of the right which meet them.

ARTICLE SECOND.

OF THE ARRANGEMENT OF THE LARGE TRUNKS WHICH ARISE FROM THE UPPER PART OF THE ARCH OF THE AORTA.

§ 1335. From the upper transverse part of the arch of the aorta arise the trunks which carry the blood to the head, the neck, the upper and anterior part of the chest, the upper extremities, and partly to the pericardium, the mammary glands, and the lungs.

There are usually three trunks, which arise a few lines distant from each other, the *common trunk*, or the *innominata* artery (*truncus communis*, s. *innominatus*), from whence arise the right subclavian and the right carotid arteries, the *left subclavian* and the *left carotid* arteries. The *innominata* artery is situated farther to the right and in front of the others; the left carotid artery in the centre and a little farther back; finally, the left subclavian artery most on the left and farther back than the other two.

After birth the origin of the left subclavian artery sometimes but not always occupies the highest part of the arch of the aorta, while in the fœtus it arises the lowest. So likewise in the fœtus the innominata artery occupies the highest part of the arch of the aorta.* The innominata artery, in ascending from left to right, is situated in front of the trachea. It is separated from the vertebral column by the longus colli muscle, and from the sternum by the sterno-thyroideus and by the left subclavian artery at its side. It is most generally an inch long, rarely longer: sometimes, however, it is two inches long, and then the trunk reaches the inferior edge of the thyroid gland.

The left carotid artery arises more perpendicularly on the left side along the trachea.

The right carotid and right subclavian arteries are shorter than the synonymous arteries on the left side.

The diameter of the vessels of the two sides is the same, or at least those of the right side are but little larger than those on the left.

The innominata artery usually arises at the side of the left carotid artery; the left subclavian artery arises from the aorta, at some distance from the latter; but the interval between them is not always very great.

The above-mentioned arrangement is the most common; we may then consider it as the normal arrangement. Frequently however, at least once in eight times,† the number of the trunks given off from the arch of the aorta varies. This number may be increased or diminished. In the former case, vessels, which are generally branches, arise directly from the arch of the aorta; in the latter case, one of the three primitive trunks or frequently all of them are blended with each other and form but one.‡

* Sabatier first pointed out this difference. (See his *Memoire sur les changemens qui arrivent aux organes de la circulation du fœtus lorsqu'il a commencé à respirer*; in the *Mem. de l'Institut*; *sc. phys. et math.*, vol. iii. p. 342.) We are however satisfied, by numerous observations, that it is not by any means constant. Thus most anatomists have disregarded it. Portal even asserts the contrary (*loc. cit.*, p. 185), for he states "that the trunk of the left subclavian artery opens into the aorta a little lower than the other two trunks"

† Bichat's assertion that "the arrangement of these arteries is but slightly subject to variation" is incorrect. Haller makes almost the same statement, and with no more foundation. Nor is Barclay more correct in asserting that "the cases are rare where a vertebral artery, a thyroid, a thymic, a pericardiac, or an internal mammary arise from the arch." Only the anomalies of the internal mammary artery are rare.

‡ Besides all insulated descriptions of the anomalies in the trunks which arise from the arch of the aorta, we may consult the following works, in which this question has been specially examined, and in a more or less general manner:—Bœhmer, *De quatuor et quinque ramis ex arcu aortæ provenientibus*, Halle, 1741.—Neubauer, *Descriptio anatomica arteriæ innominatæ et thyroideæ imæ*, Jena, 1772.—Huber, *De arcus aortæ ramis*; in the *Act. Helvet.*, vol. viii. p. 68-102.—Walter, *Sur les maladies du cœur*; in the *Nouv. Mém. de Berlin*, 1785, p. 37.—Malacarne, *Oss. sopra alcune arterie del corpo umano nello stato preternaturale e nello stato morboso*; in the *Osservaz. di chirurgia*, ii. Turin 1784, p. 119.—Ryan, *De quarund. arteriarum in corp. hum. distributione*, Edinburgh, 1810.—Koberwein, *De casorum decursu abnormi*, Wittenberg, 1810.

§ 1336. The number of the primitive trunks is increased more frequently than diminished. Most frequently we find four trunks, one more than the normal number.

This anomaly does not always occur in the same manner.

§ 1337. Our observations on this subject are principally as follow:

1st. Most generally the left vertebral artery, which is normally a branch of the subclavian artery, arises directly from the aorta. This is the most common anomaly.* Notwithstanding the abnormal origin of the left vertebral artery from the arch of the aorta, the number of trunks is not increased; because at the same time the left carotid artery passes to the right and becomes a branch of the innominata artery. This arrangement is remarkable, for it announces an effort tending to bring the anomaly to the normal type of formation.

2nd. After this variety, the most common is that where the inferior thyroid artery, or a portion of it, which is always the thyroid portion, arises from the arch of the aorta. This anomaly occurs on the right side more frequently than on the left, and this vessel then arises, like the left vertebral artery, between the innominata and the left carotid artery.

Besides these, we sometimes see coming from the arch of the aorta, at no determinate place, and most generally a little before the large trunks, and not on the same line with them,

3rd. A *thymic* artery (*A. thymica*), or

4th. An *internal mammary* artery (*A. mammaria interna*).

Less frequently, four trunks arise from the aorta, when the right subclavian artery comes directly from the arch of the aorta. We here find many differences.

5th. The *right subclavian* artery arises farthest to the right, or

* Bichat is also incorrect in saying that this anomaly is more rare than an increase in the number of the trunks of the aorta by a most inferior thyroid artery. Sabatier goes even farther, for he does not mention it at all, although he states several other anomalies which increase the primitive trunks of the arch of the aorta (*Anat.* vol. iii. p. 7). Portal also is silent in regard to it, and only mentions the division of the trunk of the innominata among the causes which increase the number of the arteries given off directly by the arch of the aorta (*Anat. med.* vol. iv. p. 155). In fact, in another place he states that the left vertebral artery arises directly from the aorta; but he adds, contrary to what is the fact, that this arrangement is very rare. Monro does not mention it when treating of the anomalies of the trunks which arise from the arch of the aorta (*Outlines*, vol. iii. p. 276, 4th ed., although he speaks of them when treating of the varieties of the subclavian artery (*loc. cit.*, p. 301). Sœmmerring, on the contrary, very properly seems to regard it as the most frequent anomaly, and mentions it as the first case where four arteries arise from the arch of the aorta. Boyer (*Tr. d'anat.*, vol. iii. p. 41) asserts that the origins of the left vertebral and of a most inferior thyroid artery are equally common and just as frequent. It has been asserted that this anomaly was more frequent in the south of Germany than that of the origin of the right subclavian artery directly from the aorta. We are satisfied from observation that this is incorrect; but we cannot agree to it, because other anatomists of great authority, particularly Haller (*Ic. an. fasc.* vi. p. 1), Neubauer (*loc. cit.*, p. 287), Sœmmerring and Boyer (*loc. cit.*, p. 25), assert exactly the contrary, and it is refuted by comparing the number of known cases which mention the different anomalies in the trunks of the arch of the aorta.

6th. This, which is much more common, arises farthest to the left, below the left subclavian artery.

Between these two formations there are several degrees; for the right subclavian artery arises

7th. Between the right and left carotid arteries; sometimes

8th. Between the left carotid and the left subclavian artery.

Of these five anomalies, in all of which the right subclavian artery is insulated from the right carotid, the second is undoubtedly the most frequent. When it exists, the right subclavian artery generally passes between the esophagus and the trachea, seldom before the latter, and goes to the right arm.

9th. This division of the innominata artery is sometimes attended with the transposition of both carotid arteries; so that

10th. First the left, then the right carotid artery, next the left subclavian artery, and finally the right subclavian arise; or

11th. Both of the carotid arteries and the right subclavian artery arise in their normal places, but the origin of the left subclavian artery is farther to the right.

But the separation of the right subclavian artery from the right carotid does not necessarily increase the number of the trunks; for then both carotids are usually blended into one trunk, an arrangement to which may be applied our remarks upon the analogous union occurring when the vertebral artery arises directly from the arch of the aorta.

§ 1338. More rarely five trunks arise directly from the arch of the aorta. When this occurs,

12th. The aorta gives off, besides the usual three trunks, the left vertebral artery, and the right internal mammary artery;* or,

13th. It gives off a right inferior thyroid artery,† or, the innominata artery divides into the right subclavian and right carotid artery, the former arising farthest on the right; and besides,

14th. The left vertebral artery,‡ or the right inferior thyroid artery, arises directly from the aorta; or,

15th. The right subclavian artery arises below the left, at the same time that the trunk of the innominata is divided into the subclavian and carotid arteries, and that the left vertebral artery arises directly from it.‖ Finally, sometimes, although seldom, instead of three trunks,

16th. We have six. The aorta then gives origin to the right subclavian and carotid arteries, separately; the right vertebral artery arises between them, and the left vertebral artery springs directly from

* Bœhmer, *loc. cit.*; in Haller, *Coll. diss.*, vol. ii. p. 453.
† We have seen this anomaly twice.
‡ Loder, *Nonnull. arter. variet.*, Jena, 1781.
§ Petsche, in Haller, *Coll. diss.*, vol. vi. § 44.
‖ Koberwein, *De decursu vasorum abnorm.*, Wittenberg, 1813.

the arch of the aorta, between the left carotid and subclavian arteries.*

§ 1339. The number of the trunks is diminished in several modes.

17th. The left carotid artery is a branch of the innominata, or,

18th. It arises by a common trunk with the subclavian artery of the same side; or,

19th. The first trunk divides into the two carotid arteries, the second into the two subclavian arteries; or,

20th. The right trunk is the right subclavian artery, the left is the common trunk of the left subclavian and the two carotid arteries.

The last anomalies are as rare as the first is common. Our observations have proved that the latter and the distinct origin of the left vertebral artery, are the most common.

§ 1340. Sometimes, when the number of the trunks is neither increased nor diminished, their arrangement varies from the normal state. Abnormal unions and divisions then exist, of which the principal are,

21st. The innominata artery is divided, but the two carotids arise by a common trunk, which is implanted in the arch of the aorta, between the two subclavian arteries.

22nd. The innominata artery is divided on the right side into the subclavian and carotid arteries; but on the left side both of these arteries arise by a common trunk. The preceding formation leads then to a total inversion of the origin of the vessels.

23rd. The innominata artery is divided, but we find a common trunk for both carotid arteries, and 2nd, one for the left, and 3rd, one for the right subclavian artery, which then arises farther from the left side than usual, most generally below the left, and goes to the right upper extremity, passing before or behind the trachea, and most commonly the esophagus.

24th. The innominata artery also gives off, besides its usual branches, the left carotid artery; but the left vertebral artery then arises directly from the arch of the aorta, between the other two trunks.

§ 1341. Finally, the least possible anomaly is where only the relative situations of the larger trunks which come from the arch of the aorta are changed; they are,

1st. The trunks arise uncommonly near each other. The left carotid artery then most generally approaches the innominata. This anomaly makes the transition to the union of the two carotids into one. Again, but more rarely, the left carotid artery separates from the innominata, while the left subclavian artery approaches it. This anomaly leads to another case which is rarer, where the left carotid and left subclavian arteries arise by a common trunk.

* This anomaly has been seen by F. Müller, formerly demonstrator at Copenhagen, who communicated it to me.

Sometimes also the three trunks are so near each other, that they in fact arise from the same surface, or form but one stem. This anomaly evidently makes the transition to that where the aorta divides, directly after its origin, into an ascending and a descending trunk.

2nd. The distance between the origin of the trunks is sometimes unusually great. Thus we have found in a child two years old, the left carotid artery nearly an inch distant from the innominata; the left subclavian artery was also nearly an inch from the left carotid; the arch of the aorta was extremely sharp, and the left carotid artery arose from the angle formed by the union of the right and left portions.

ARTICLE THIRD.

PRIMITIVE CAROTID ARTERY.

§ 1342. The *primitive* or *common carotid* artery (*Carotis primitiva*, s. *cephalica*) ascends along the trachea, which generally separates that of the right and left sides. It usually extends to the upper extremity of the larynx, where it bifurcates, at some distance from the angle of the lower jaw, and seldom behind it. It is situated very superficially, especially its central part, so that it is most easily found there. It is covered before by the sterno-cleido-mastoideus, the sterno-hyoideus and the omo-hyoideus muscles; the internal jugular vein and the pneumogastric nerve are on the outside, and a little in front of it; the latter is situated between the two vessels; inside are the trachea, the larynx, the thyroid gland, and also the esophagus; behind it is the cervical portion of the great sympathetic nerve, the longus colli and rectus capitis major muscles, and the inferior thyroid artery, which separate it from the vertebral column. The inferior thyroid artery seldom passes before it. The primitive carotids are generally situated on the two sides of the trachea, the right a little more forward than the left; but sometimes, particularly at their lower parts, they are placed somewhat before this canal. The right carotid artery assumes this arrangement, especially when the innominata arises unusually far on the left, and the left when it arises from this trunk. In both cases the arteries cross the interior face of the trachea. These anomalies should be known, as they endanger the carotid arteries in the operation of tracheotomy.

The primitive carotid is enclosed with the internal jugular vein and the pneumogastric nerve, in a very firm cellular sheath.

§ 1343. From the primitive carotid artery arise only small and inconstant vessels, which go to the surrounding parts, but sometimes, and not unfrequently, it gives off, especially on the right side, the superior or the inferior thyroid artery, either wholly or partially; the latter is more common. The origin of the inferior is, in this case, towards the lower part; that of the upper, near the upper end of the artery.

§ 1344. The common carotid artery divides, generally as high as the upper edge of the thyroid cartilage, into two branches, one of which, the *internal carotid*, supplies the brain and the eye, while the other, the external carotid, belongs to the upper part of the neck, the skull and the face. It sometimes bifurcates much higher up, opposite the upper extremity of the styloid process, but not till it has given off the larger of the longer branches of the external carotid.* This arrangement is very analogous to that where the primitive trunk does not divide into two large branches, but having given off the branches of the external carotid artery.† This anomaly consists evidently in the premature division of the trunk, while its branches are given off too soon. In some few cases the division extends much farther, and attains even the trunk of the primitive carotid. This trunk then begins to divide very soon, and it sometimes bifurcates, opposite the sixth cervical vertebra, but the two branches remain connected with each other.‡

The distance between the place of bifurcation, and the thyroid cartilage is the same at all periods of life :§ but the distance between the bifurcation and the angle of the lower jaw is much greater in the child than in the adult, on account of the development of the teeth, so that during early life the two large inferior branches are loose for some distance.

These two branches ascend almost perpendicularly. Below they are situated directly at the side of each other. The internal is at first more superficial than the external carotid, but it afterwards becomes deeper. Their proportional volume is not always the same. The differences depend partly on the age, and partly on the distribution of the external carotid artery.

In the first respect, the internal carotid artery is always larger than the external in infancy, on account of the size of the brain : in the second, the external is larger than the internal carotid in the adult, when it gives off the superior thyroid artery, and smaller than it, on the contrary, when the latter comes from the primitive carotid.

I. EXTERNAL CAROTID ARTERY.

§ 1345. The *external carotid* artery (*Carotis externa*, s. *facialis*, s. *A. pericephalica*) ascends under the posterior belly of the digastricus muscle of the lower jaw, is situated between the ear and the ascending branch of the lower jaw, where it is entirely covered by the parotid gland, and divides at the neck of the lower jaw into a supercial branch, which is the *temporal* artery, (*A. temporalis*), and a deeper seated

* Burns, *Surgical anatomy*, Edinburgh, 1811, p. 95, 96.
† Idem, *ibid.*, p. 95.
‡ Idem, *ibid.*, same page.—We regret that the author does not say whether the anomaly existed on the two sides or only on one side, (perhaps the left?)
§ Idem, *ibid.*, p. 379.

branch, the *internal maxillary* artery, (*A. maxillaris interna*). But it always gives off large branches, before it bifurcates. These branches generally detach themselves gradually, one after another. Sometimes, however, the external carotid artery forms a short trunk, which divides directly above the bifurcation of the primitive carotid into the large inferior branches, and the broad continuation of the trunk.

§ 1346, Before bifurcating, the external carotid artery gives off branches principally in three directions: forward, backward, and inward.

A. ANTERIOR BRANCHES.

§ 1347. The anterior branches are the *superior thyroid* artery, the *lingual* artery, and the *facial* artery.

I. SUPERIOR THYROID ARTERY.

§ 1348. The *superior thyroid* artery (*A. thyroidea superior*) is the lowest branch of the external carotid artery. Its origin varies: it generally arises some lines above the bifurcation of the primitive carotid; but it not unfrequently detaches itself at the bifurcation, or below, and even from the trunk of the primitive carotid; sometimes an inch below its bifurcation.

Its size also varies, and it is in the inverse ratio of that of the inferior thyroid artery. When the latter is entirely deficient, the superior is much larger than usual; it is on the contrary very small, when the inferior thyroid artery is very large, or when the lowest thyroid artery exists.

Sometimes, but unfrequently, it arises by a common trunk, with the lingual artery, and in some subjects this trunk comes from the primitive carotid.

On the other hand, we not unfrequently find the superior thyroid artery double, because the branches which it generally gives off are detached lower than usual. The arrangement and size of the left and right thyroid arteries vary; sometimes one of them is deficient, while the other is very large.

§ 1349. When the artery does not arise much lower than usual, nor from the primitive carotid, it always descends inward and forward, being at first slightly concave above, and very tortuous. It sometimes gives off a large branch immediately after arising, which detaches itself from its posterior and inferior part, and goes to the sterno-cleido-mastoideus muscle. It then soon divides into an upper and a lower branch. Sometimes it bifurcates near or even at its origin.

The *upper* or *laryngeal* branch (*ramus laryngæus*) arises from the external carotid artery, according to our observations, once in eight times. It goes downward, forward and inward, on the thyroid cartilage, and frequently gives branches to the omo-hyoideus, the sterno-hyoideus, the sterno-thyroideus, the hyo-thyroideus and the crico-thyroideus.

muscles, which come sometimes from the lower branch, or directly from the external carotid artery : furnishes a large anastomotic vessel which goes across the cricoid cartilage, and unites with the branch given off by the synonymous artery opposite ; finally it penetrates within the larynx, passing generally between the hyoid bone and the thyroid cartilage, sometimes, but more rarely, near the upper edge of the latter, by an opening which exists there, or even between the cricoid and the thyroid cartilages.* Having arrived at this organ, it distributes itself upon its internal membrane, and also to its muscles, anastomoses very frequently with the synonymous artery of the opposite side, and even sends ramuscules outside of the larynx, which communicate on its surface with those of the other side, and with the ramifications of the thyroid branch.

The *inferior* or *thyroid branch* (*R. thyroideus*) is the continuation of the trunk ; it sometimes furnishes many or even all the muscular branches which we have described as coming from the laryngeal branch ; but small twigs always arise from it and go to the middle and inferior constrictors of the pharynx and to the crico-thyroideus muscle. After which it descends downward into the thyroid gland, and generally divides, at its upper extremity, into two branches, a posterior and inferior, and an anterior and superior, which soon subdivide. The former penetrates posteriorly into the thyroid gland, and anastomoses along its posterior face with the branches of the inferior thyroid artery ; the other proceeds along its upper edge, gives off considerable branches which expand on its anterior face, and anastomose, by very large vessels, with the synonymous branch of the opposite side.

When the superior thyroid artery is divided into two separate trunks it often happens, but not always, as one might think from what several anatomists say,† that the laryngeal branch is distinct from the thyroid branch, and situated above it. Sometimes however, but very rarely, the superior thyroid artery gives off only the trunk of the muscular branches and the laryngeal branch.

II. LINGUAL ARTERY.

§ 1350. The second branch is the *lingual* artery (*A. lingualis*, s. *sublingualis*, s. *ranina*), which arises farther inward, most generally a few lines, and sometimes an inch, above the preceding, and rarely by a

* We have remarked that this is the most common arrangement; so that our observations in this respect agree with those of Mayer, (*loc. cit.*, p. 249), and with Bichat (*loc. cit.*, p. 149), who both say that the laryngeal branch commonly penetrates into the larynx by passing between the hyoid bone and the thyroid cartilage. Murray (*loc. cit.*, p. 11) indicates exactly these three arrangements, but does not say that the first is the most frequent. Sœmmerring (p. 131) entirely neglects this, and speaks only of the two which are less frequent. Sabatier (p. 115) mentions only the third.

† Mayer, (*loc. cit.*, p. 49) asserts, but wrongly, that the laryngeal always arises a quarter of an inch above the thyroid artery. Sabatier (*loc. cit.*, p. 15) ; Sœmmerring (*loc. cit.*, p. 131) ; Portal, (*loc. cit.*, p. 159).

trunk in common with the superior thyroid artery, but more frequently, and nearly once in seven times, with the facial artery. It is generally a little larger than that we have mentioned.

This artery curves considerably, and its convex part looks upward, passes then directly over the large horn of the hyoid bone, goes horizontally forward, glides between the middle constrictor of the pharynx and the hyoglossus muscle, and then ascends towards the base of the tongue, where it recommences, and then goes horizontally forward, along the inferior face of this organ.

From its posterior part arise, 1st, several branches, which go to the hyo-glossus muscle and middle constrictor of the pharynx, and which, having passed through the latter, enter the digastricus and the thyro-hyoideus muscles, and the submaxillary gland; 2nd, a branch which goes downward and inward, between the genio-glossus and the genio-hyoideus muscles directly on the hyoid bone, gives branches to these muscles, especially to the first, and anastomoses with that of the opposite side. It is called the *hyoid* branch (*R. hyoideus*).

From the central ascending part arise one or more *dorsal arteries of the tongue* (*R. dorsales linguæ*), which go downward to the posterior part of the tongue, on the inside of the hyo-glossus muscle, ascend upon the back of this organ, and advance to the epiglottis.

The lingual artery divides, in front of the hyo-glossus muscle, into a ranine and a sublingual artery.

The *ranine* artery (*A. ranina*) is larger than the other, and is a continuation of the trunk. It extends deeply between the lingualis and genio-glossus muscles, proceeds forward, gives off several branches in its course, and finally anastomoses with that of the opposite side behind the summit of the tongue, at the upper end of its frenum.

The *sublingual* artery (*A. sublingualis*) is more external and more superficial than the preceding. It passes over the mylo-glossus muscle, between it and the sublingual gland, gives off branches to it, to the hyo-glossus muscle, to the lingualis muscle, and to the proper membrane of the mouth, passes over the mylo-hyoideus muscle, and anastomoses with the inferior maxillary branch of the facial artery.

This artery sometimes arises from the facial.

III. FACIAL ARTERY.

§ 1351. The third branch, the *facial* or *external maxillary* artery (*A. facialis, facialis anterior, angularis, maxillaris externa*), varies in respect to its origin, size, and extent; it is commonly the largest of the three anterior branches of the external carotid, and supplies all the anterior part of the face; but sometimes also it extends only to the angle of the mouth, and the other branches are supplied from the temporal artery. There is scarcely a vessel which varies so much as this, even in the two sides of the same body.

It passes under the posterior belly of the digastricus muscle to go to the angle of the lower jaw. In this place it proceeds first horizontally behind and within the inferior edge of the lower jaw, then goes obliquely upward and forward on the inside of this bone and of the upper jaw.

It frequently gives off, directly above its origin, the *inferior* or *ascending palatine* artery (*A. palatina ascendens*, s. *inferior*), which usually arises from the *ascending* or *inferior pharyngeal* artery (*A. pharyngæa ascendens*); we shall describe it with that.

It then gives small ramuscules to the digastricus and stylo-hyoideus muscles.

Farther on, it gives off considerable branches which go to the submaxillary gland (*R. glandulares*), and goes forward in one of its grooves. Farther onward, it gives off one or more ramuscules to the pterygoideus internus muscle.

It then furnishes the *submental* artery (*R. submentalis*). This arises near the lower edge of the lower jaw, and proceeds along it, directly below the attachment of the mylo-hyoideus muscle, and over the anterior belly of the digastricus muscle, gives ramuscules to both of these muscles, anastomoses with the sublingual artery, and thus goes forward, where it communicates with that of the opposite side, on the centre of the lower edge of the lower jaw. Thence it re-ascends into the substance of the lower lip, to which it gives twigs, as also to the skin of the chin, and anastomoses with the descending branches of the coronary artery of the lower lip, and also with those of the inferior dentar artery, which emerges from the mental foramen.

When the sublingual artery is a branch of the facial it arises a little, and even in most cases directly before the submental.

The continuation of the trunk, or the proper facial artery, turns upon the lower edge of the lower jaw, generally directly before the anterior edge of its ascending branch, thus attains the outer face of this bone, descends very obliquely between the masseter and the triangularis oris muscles, arrives at the angle of the lips, and gives off in this place several branches, which enter the masseter, the triangularis and the buccinator muscles and the skin.

About the centre of the space between the angle of the mouth and the under edge of the lower jaw, it generally divides into two branches. One, the continuation of the trunk, goes directly upward; the other is smaller, and proceeds more obliquely inward and forward.

The latter is the *inferior coronary artery of the lip* (*A. coronaria labii inferioris*). It passes under the triangularis oris muscle, and proceeds toward the lower lip, gives several branches to this muscle, to the levator menti, and also to the membrane of the mouth, and anastomoses both with its fellow of the opposite side and with the twigs of the submental and inferior dentar artery.

This artery is sometimes much smaller on one side than on the other. In some subjects it is even entirely deficient, and is then replaced by

that of the opposite side. Sometimes it arises much higher and comes from the superior coronary artery of the lip. In some cases it is double: one of the two then arises much above the other; but the two arteries taken together are not larger than that of the opposite side: sometimes the two branches into which the lower coronary artery of the lips is divided are very small.

After giving off this branch, the facial artery winds tortuously upward and inward. Arrived as high as the angle of the mouth, it generally divides, a little above this point, into two branches.

The larger goes inward and forward, between the fibres of the orbicularis oris, and is called the *superior coronary* artery (*A. coronaria labii superioris*). This artery proceeds directly over the loose edge of the upper lip, gives ramuscules to the orbicularis oris, to the levator labii superioris, to the skin, to the buccal membrane, meets that of the opposite side and anastomoses with it by a broad communication similar to that between the inferior coronary arteries. The two coronary arteries usually anastomose together in two places by large branches: sometimes the anastomosis between the arteries is very small on one side, but is replaced by a very large branch, which arises highter up from the facial, and which communicates with the artery of the septum of the nose.

Both coronary arteries are very tortuous, but the upper is more so than the lower. Both anastomose with the synonymous arteries of the opposite side, and these anastomoses are proportionally the largest in the body, when we consider the vessels between which they occur.

The superior coronary artery always gives off from its centre, where it anastomoses with that of the opposite side, a branch, which goes upward toward the nasal septum, which is called the *artery of the septum of the nose* (*A. nasalis septi*). Sometimes this artery is single, sometimes double, and even triple, at its origin: in the last two cases it is frequently given off by the coronary artery of one side; but however this may be, it divides near the septum of the nasal fossæ into at least two branches, a right and a left, each of which proceeds along the lower edge of the septum and the inner part of the corresponding nostril to the end of the nose, and also sends ramuscules, which re-ascend on the cartilaginous septum.

Besides these branches, the coronary artery gives off sometimes before, more externally and on one side only, or on both, another considerable branch (*R. pinnalis*), which goes to the ala and the outer part of the nostril; but this branch more frequently comes from the next one.

The facial artery, after giving off the superior coronary, consists only of a smaller branch, which may be called the *common external nasal* artery (*A. nasalis externa communis*). This artery is very tortuous, and ascends obliquely forward under the levator labii superioris muscles, to which it gives ramuscules, goes toward the nose, and anastomoses by considerable branches with the infra-orbitar

artery. It usually gives off, opposite the nostril, the *lateral arteries of the nose* (*R. pinnales*, s. *laterales nasi*), and also sends off numerous smaller arterial twigs, which anastomose with each other and also with those of the septum and their corresponding ones of the opposite side, which are called the *dorsal* arteries (*R. nasales dorsales*), and which always communicate on the nose by several large or small branches with the ophthalmic artery. Finally, it terminates on the back and side of the nose, and never, even in its greatest degree of extension, goes beyond the upper edge of the cartilaginous portion of this organ.

The two coronary and the common external nasal artery, and more frequently only the superior coronary and the latter, sometimes arise not only from the above facial but also from the transverse facial artery, which then is much larger, while the other is smaller, although the facial artery is not necessarily more developed at its lower part; we likewise observe in other subjects that this artery is very much developed at its upper part, although the lower part does not produce more branches than usual. We have seen the sublingual artery coming from it at least several times, and the facial artery at the same time was as large as usual. In other cases, on the contrary, it gives off neither of the two coronary arteries, while the sublingual artery arose as usual; but the submental artery was uncommonly small.

Hence it appears that the facial artery is always the principal source of communication, 1st, between the superficial and the deep-seated branches of the external carotid by its anastomosing with the infra-orbitar, the nasal, and the dentar arteries; 2d, between the external and the internal carotid arteries by its anastomosing with the ophthalmic artery.

§ 1352. Numerous small branches, which go to the masseter and pterygoidei muscles and to the parotid gland (*R. masseterici, pterygoidei, et parotidei*), arise externally and internally from that part of the carotid artery situated between the ascending branch of the lower jaw and the ear.

A larger anterior branch, the *transverse facial* artery, which will be described hereafter, rarely arises from its upper extremity, directly below its divison.

B. INNER BRANCH.

I. ASCENDING OR INFERIOR PHARYNGEAL ARTERY.

§ 1353. Most generally only one branch arises from the inner face of the external carotid artery; this is the *ascending* or *inferior pharyngeal* artery (*A. pharyngæa ascendens*, s. *inferior*, s. *posterior*), which comes sometimes from the bifurcation of the primitive carotid, sometimes from the origin of the internal carotid, but more frequently from

the occipital artery,* and is sometimes replaced by the branches of the facial artery.

If it is a branch of the external carotid it arises very deeply, most generally above the inferior thyroid artery; so that it is the second branch from the trunk; but sometimes it comes higher up and even above the facial artery.†

It is sometimes double: then the two inferior pharyngeal arteries rarely come from the external carotid; one arises from the latter, and the other from one of the secondary branches above described, or from the internal carotid artery.‡

It is always the smallest branch of the external carotid artery.

It goes perpendicularly upward, on the inside of the external carotid artery, and in the same direction with it, between it and the pharynx.

It gives off first the descending branches to the constrictors of the pharynx, and to the anterior and lateral muscles of the neck.

A little farther it divides into two branches, one of which, the *pharyngeal* branch (*R. pharyngæus*), is distributed principally to the constrictors of the pharynx, and communicates with the pharyngeal branches of the superior thyroid artery; the other, termed the *posterior meningeal* artery (*A. meningæa posterior*), ascends through the posterior foramen lacerum of the skull, or through a special opening near the occipital condyle, and is distributed to that part of the dura mater which lines the lower part of the skull.

C. POSTERIOR BRANCHES.

§ 1354. The posterior branches of the external carotid artery are 1st the *occipital*, and 2nd the *posterior auricular* artery.

I. OCCIPITAL ARTERY.

§ 1355. The *occipital* artery (*A. occipitalis*) is a considerable branch, but much smaller than the three anterior branches, which usually arise opposite the lingual or the facial artery; seldom or never above or below them. It rarely comes from the internal carotid artery. It is very deeply situated; goes upward and backward, often gives off,

* Sœmmerring states that it sometimes arises from the superior thyroid artery. We have never seen this, nor is it mentioned by any other anatomist. Sœmmerring, it is true, quotes Mayer; but the *laryngo-pharyngean* artery (*A. laryngo-pharyngæa*) described by Mayer, is the laryngeal branch of the superior thyroid artery, and describes the inferior pharyngeal artery as the posterior artery of the throat.

† Bichat asserts that it arises between the facial and lingual arteries. Our observations lead us to think that Sœmmerring is more correct in saying that it rarely arises higher than the lingual. Murray places it behind the facial, but adds that its origin is near that of the lingual. Portal also places it nearly opposite this latter, as do Sabatier and Mayer. Boyer states that it arises opposite the facial.

‡ Sœmmerring asserts that when it is double, the lower trunk arises from the primitive carotid, and the superior from the internal carotid. This arrangement exists sometimes, but it is not the law. That mentioned by us is much more common.

soon after arising, branches which go to the posterior belly of the digastricus muscle of the lower jaw, then a descending branch, which goes to the sterno-cleido-mastoideus muscle and the upper lymphatic glands of the neck, higher up, gives off wholly or partially the ascending pharyngeal artery, then extends below and deeply between the transverse process of the first cervical vertebra and the mastoid process of the tempora lbone, continues its course backward, passing under the complexus minor muscle, then assumes a horizontal direction, gives branches to the upper extremity of the sterno-cleido mastoideus, to the complexus minor, to the transversalis colli, to the small lateral and posterior muscles of the head, and then ascends on the occipital bone, covered by the upper part of the splenius muscle, to which it gives branches. It is then called the *superficial occipital* artery, proceeds directly below the skin, on this bone to the vertex, terminates in a large anastomosis, formed by its branches with each other and with those of the frontal, the superficial temporal and the synonymous artery of the opposite side.

At the place where the occipital artery leaves the space between the transverse process of the first cervical vertebra and the mastoid process of the temporal bone, to pass on the obliquus capitis major muscle of the head, it always gives a deep or descending branch. This branch being sometimes very considerable, and nearly as large as the continuation of the trunk, we may then admit that the artery divides at this place into a *superficial* and *deep-seated* branch. When this is the case, it descends to the middle of the back, between the splenius, complexus, digastricus and transversalis colli muscles. Sometimes, however, it is very small, and then it is distributed in the small posterior muscles of the head.

The deep-seated branch anastomoses many times with the vertebral artery, and with the cervical branches of the inferior thyroid artery.

From the superficial occipital artery constantly arise one or several branches, which pass into the cranium through the mastoid foramina; more rarely through the large occipital foramen or the foramen lacerum, which are distributed to the posterior and inferior part of the dura mater. They are termed the *posterior meningæal* arteries (*A. meningeæ posteriores ab occipitali*).

II. POSTERIOR AURICULAR ARTERY.

§ 1356. The *posterior auricular* artery (*A. auricularis posterior*) is generally much smaller than the preceding, and arises a little above it, in the substance of the parotid gland, and is generally separated from it only by the stylo-hyoideus muscle. Sometimes it arises from this artery, and rarely somewhat higher, directly below the division of the internal carotid artery into the superficial temporal and the internal maxillary artery. It goes upward, at the side and behind the trunk of the external carotid artery, and passes through the parotid gland, near the mastoid process. There it gives, 1st. at its lower posterior

part, branches which go to this gland, to the posterior belly of the digastricus muscle, to the stylo-hyoideus and to the upper part of the sterno-cleido-mastoideus muscles ; 2nd, from its superior and anterior part, an ascending branch, the *stylo-mastoid* artery (*A. stylo-mastoidea*), which furnishes ramuscules to the auditory passage, penetrates into the canal of the facial nerve through the stylo-mastoid foramen, distributes itself to the mastoid process, to the tympanum, and also to a portion of the labyrinth, and anastomoses with a branch of the middle meningeal artery. The trunk of the artery then divides at the level of the mastoid process into two branches, an *inferior* or *muscular* and a *superior* or *auricular* branch.

The interior branch goes transversely outward, over the upper part of the splenii muscles, gives ramuscules to these muscles, to the trapezius and to the skin, anastomoses with the superficial occipital artery, and advances toward the occiput.

The superior branch goes upward and backward. It usually divides into two or three branches, one of which, the more transverse, goes backward to the mastoid process, and gives branches to it, also to the occipitalis muscle ; while the other, or the others, attain the posterior part of the concha, distribute the small arteries to the retrahentes auriculæ, and to the transversus auriculæ muscles, then pass over the concha, and thus come on its internal face, where they lose themselves in the skin and the mucous membrane.

D. TERMINATION OF THE EXTERNAL CAROTID ARTERY.

§ 1357. The external carotid artery terminates at the neck of the lower jaw in two trunks, a superficial, the temporal artery ; the other deep-seated, the internal maxillary artery.

I. TEMPORAL ARTERY.

§ 1358. The *temporal* artery (*A. temporalis*) is smaller and more superficial than the internal maxillary, and continues in the direction of the trunk. It goes upward and outward. Its branches may be divided into *anterior* and *posterio.*

The anterior branches are principally the following :

1st. The first branch is often the *upper masseteric* artery (*A. masseterica superior*) which penetrates sometimes to the external and sometimes to the internal layer of the masseter muscle, but frequently comes from the next.

2nd. The *transverse facial* artery (*A. transversa*, s. *transversalis faciei*)* is the second, often the first branch of the artery, and arises

* Sœmmerring (*loc. cit.*, p. 169) mentions it as arising from the external carotid artery, before it bifurcates, and says also that it sometimes comes from the internal

directly above the bifurcation of the external carotid artery. Sometimes, but unfrequently, it arises from the external carotid artery, and most generally from the bifurcation. It goes forward, with the canal of Stenon, on the masseter muscle, directly below its upper edge, gives off the superior masseteric artery, when this does not come from the temporal artery, sends several ramuscules to the skin, penetrates forward into a greater or less portion of the orbicularis palpebrarum muscle, and anastomoses, by a considerable number of ramifications, with the facial artery, which it meets, and with the infra-orbitar artery. Sometimes this gives off all the upper part of the facial artery.

In some subjects its ascending ramuscules extend much higher, and reach the outer extremity of the edge of the orbit.

The *middle temporal* artery (*A. temporalis media*) generally arises some lines above the transverse facial artery, a little below the malar bone, a considerable branch, which proceeds first from below upward, gives off one or several ramuscules to the upper part of the masseter muscle, then curves backward at a right angle, between the trunk and the temporal muscle, and terminates partly in small twigs, which penetrate into the substance of the muscle where they anastomose with those of the deep temporal artery, and partly in superficial branches, which are distributed on the auditory passage, where they communicate with those of the posterior auricular artery.

After giving off this artery, the trunk of the temporal artery goes upward and forward, on the temporal muscle, directly under the skin, and describes a considerable arch, which is convex posteriorly and terminates as the *anterior temporal* artery (*A. temporalis anterior*), anastomosing several times with the superciliary artery, and giving branches to the frontalis muscle and to the skin of the forehead.

Small inconstant branches come from the anterior and concave part of the arch which it describes, these go forward into the outer part of the orbicularis palpebrarum muscle, and communicate with the ascending branches of the transverse facial, and also with the upper ramuscules of the anterior temporal artery.

The posterior branches of the superficial temporal artery are,

1st. The *anterior inferior auricular* arteries (*A. auriculares anteriores inferiores*), usually three or four in number, which arise directly above one another from its lower part, and are expanded in the inferior and anterior part of the concha.

2nd. The *anterior* and *superior auricular* artery (*A. auricularis anterior superior*) which is often single, rarely double; it arises nearly opposite the preceding branches, and goes to the upper and anterior part of the concha, and to the attollens auriculæ muscle.

rotid artery, and cites as authorities Mayer, Murray, and Walter. But Murray ites expressly that it is the fourth branch of the external temporal artery . 17). Mayer describes it as the tenth branch of the external carotid artery (p. 81), asserts positively that it arises about a line above the internal-maxillary artery. e descriptions of Portal (p. 186), Boyer, (p. 42), Bichat (p. 152)), and Tenon 267), agree, like that of Murray, with the results of our observations.

3rd. Two or three larger branches usually go backward, inward, and upward, and anastomose with each other and with those of the opposite side, and with the superficial occipital artery, which sometimes partly replaces them. They are called the *posterior temporal* arteries (*A. temporales posteriores*), and they are usually wrongly considered as forming, in opposition to the anterior temporal artery, but one branch.

II. INTERNAL MAXILLARY ARTERY.

§ 1359. The *internal maxillary* artery (*A. maxillaris interna*, *A. orbito-maxillaris*) is larger than the preceding, but differs more from the direction of the primitive trunk, and is situated more deeply, so that it cannot be seen entirely till the zygomatic arch and the outer part of the body of the upper maxillary bone is removed.

Its direction changes several times in its course. First, it goes transversely inward and a little forward, behind the neck of the jaw; then it goes directly inward, and passes between the two pterygoidei muscles, or curves again a little forward. Arrived at the pterygoid process, it goes perpendicularly upward, over the pterygoideus externus muscle, and is reflected on itself as high as the floor of the orbit, so that its direction becomes horizontal. Thence it divides into several branches which descend more or less, by which it terminates, distributing itself on one side on the inner and posterior part of the nose, on the other to the outer part of the face.

Proceeding in this manner, it distributes the blood to the dura mater, to the internal ear, to the pterygoidei muscles, to the temporalis muscle, to the teeth, to the interior part of the nose, to the upper part of the pharynx, and to a part of the face, and communicates with several branches of the external and internal carotid, by the following branches, which are successively given off. It usually sends one or two to the ear, viz.:

a. The *deep-seated auricular* artery (*A. auricularis profunda*), which goes to the organ of hearing.

b. The *artery of the tympanum* (*A. tympanica*), which is distributed to the temporo-maxillary articulation, and then penetrates into the cavity of the tympanum, through the fissure of Glaser. These two branches often arise from the external carotid artery, or from the facial or temporal artery.

c. The *small meningeal* or the *external pterygoid* artery (*A. meningea parva*, s. *pterygoidea externa*) is an inconstant branch, which often arises from the meningeal or from a pterygoid artery; it gives branches to the pterygoidei muscles, to the muscles of the soft palate, and to the dura mater, near the sella turcica, and sometimes penetrates into the skull through the foramen ovale.

d. The *middle*, or *great meningeal*, or *spheno-spinal* artery (*A. meningea media*, s. *magna*, s. *spinosa*),* is the largest branch of the internal maxillary artery.

It arises from the upper part of the origin of the internal maxillary artery. It goes directly upward and gives off branches to the pterygoidei muscles, to the upper constrictor of the pharynx, to the temporal muscle, and to the muscles of the soft palate; these are sometimes, although rarely, deficient. When they do not exist they are replaced by the small meningeal artery.

The artery then, either simple or divided, enters through the spheno-occipital hole of the sphenoid bone, into the skull, and then gives off some ramifications posteriorly, which glide into the fissure of Fallopius, penetrate into the cavity of the tympanum and the canal of the facial nerve, are distributed to the membrane of the tympanum, to these nerves, and to the muscles of the tympanum, and anastomose with the stylo-mastoid artery. Others, which are anterior, sometimes penetrate into the orbit, through the malar bone or the large wing of the sphenoid bone, and to the lachrymal gland. But this trunk, covered on the outer face of the dura mater, above which it projects, and of which it is the largest artery, expands principally in the anterior and central part of this membrane. It arises, near the anterior edge of the parietal bone, at the median line of the skull, and gives off, forward and backward, numerous branches, which anastomose with the other branches of the middle, and also with those of the anterior and posterior meningeal arteries.

Besides, these branches communicate also with those of the temporal and occipital arteries.

As they project above the dura mater, and follow the grooves of the skull-bones, these indicate their course very well.

e. The *inferior maxillary* or *inferior dental* artery (*A. maxillaris*, s. *alveolaris*, s. *dentalis inferior*), which sometimes arises from the middle meningeal artery, and always comes from the lower point of the origin of the internal maxillary artery, descends between the two pterygoidei muscles, to which it gives twigs, and also sometimes to the temporal muscle; penetrates into the dental canal, through which it passes forward, gives ramifications to all the teeth and to all the lower dental nerve, which occupy the same canals as they do, then emerges from the mental foramen, and anastomoses above with the inferior coronary or labial, and below with the submental artery, and produced, like the preceding, by the facial artery.

This emerging branch most commonly arises some distance from

* Some anatomists, as Sabatier, Boyer, and Bichat, state that it is the first branch of the internal maxillary artery. We have always seen it preceded by one or more of those we have mentioned, and we have never found it, as Mayer states, arising directly from the bifurcation of the external carotid artery. According to our observations, it does not normally arise before the inferior dental artery, as Hemmerring, Murray, and Munroe assert. We have seen that Portal was correct in saying that it is given off as frequently after it or at least opposite to it.

the mental foramen, within the dental canal, and on a level with the small malar teeth, at the place where the inferior maxillary artery bifurcates to produce it and the continuation of the trunk.

f. g. Two or more *deep-seated temporal* branches (*R. temporalis profundi*) arise from the upper part of the maxillary, and are distributed to the buccinator and the pterygoidei muscles, and especially to the temporal muscle; penetrate also into the orbit, where they send branches into the lachrymal gland and the eyelids, and anastomose extensively with the ophthalmic artery.

h. The *masseter* artery (*R. massetericus*) is not constant, and arises sometimes from the external temporal, or even the external carotid, or finally from one of the deep pterygoid arteries. It passes over the semicircular notch of the lower jaw into the upper part of the masseter muscle. It gives branches also to the temporal muscle, and to the two pterygoidei muscles, especially to the external.

i. The *buccal* artery (*A. buccalis*, s. *buccinatoria*) is a very constant branch, although it often arises from the deep temporal artery, or from one of the following branches. It comes from the lower part of the inferior maxillary artery, goes downward and forward, along the outer face of the body of the upper jaw, distributes its branches in the buccinator muscles, the muscles of the upper lip, the lower part of the orbicularis palpebrarum muscle, the buccal membrane, sometimes also the anterior teeth to which it comes by several openings which exist in the upper part of the superior maxillary bone, and anastomoses with the branches of the facial, and also with those of the infra-orbital, artery.

k. The *superior maxillary* or *alvelaor* artery (*A. maxillaris superior*, s. *alveolaris*) arises sometimes from one of the deep temporal or from the infra-orbital artery. It is larger than the preceding, goes a little downward and forward, turns on the upper maxillary bone, and sends off numerous large and small branches, one of which is termed the *superior dental* artery (*R. dentalis superior*) into the teeth of the upper jaw. These branches nourish the dental capsules, the periosteum, the germ, the buccinator muscle, the zygomaticus major muscle, and anastomose with the branches of the facial and infra-orbital arteries.

l. The *infra-orbital* artery (*A. infra-orbitalis*) is generally smaller than the preceding, and arises near the bottom of the orbit. It soon engages itself in the infra-orbital foramen, and the infra-orbital canal sends some branches into the orbit and the maxillary sinus, emerges by the infra-orbital foramen, behind the levator labii superioris, thus comes on the front of the face, and terminates in a great many ramuscules, some of which go to the muscles of the upper lip, while the others anastomose with the upper dental artery, the dorsal artery of the nose, the orbitar and the palatine artery.

Finally, at the upper end of the zygomatic fossa, the internal maxillary artery divides into an ascending and a decending branch, which goes inward.

m. The *superior palatine* artery (*A. palatina*, s. *descendens*, s. *pterygo-palatina*) gives off, first, the *superior* or *descending pharyngeal* artery (*A. pharyngæa suprema*, s. *descendens*). This passes through the pterygo-palatine foramen, and expands in the pterygoid process of the bone, the Eustachian tube, and the upper part of the pharynx. Sometimes it arises from the internal maxillary artery, by a distinct trunk. The superior palatine artery descends in the pterygoid canal and divides into several ramuscules, which pass through different openings, to go to the soft parts of the palate. The trunk passes through the posterior palatine canal, comes on the palatine arch, rests directly on its lower face, describes a right angle to go forward, forming numerous curves, in its course gives off twigs to the mucous membrane of the palate and to the muciparous glands, and anastomoses forward with that of the opposite side, and sends its latter branches through the anterior palatine foramen into the nasal cavity, where they extend to the lower turbinated bone, communicating with the branches of the artery of the septum and of that of the dorsum of the nose which arise from the facial artery.

n. The last branch, the *posterior nasal* or *spheno-palatine* artery (*A. nasalis posterior*, s. *spheno-palatina*), enters through the spheno-palatine hole into the posterior part of the nasal fossa, and divides into two branches, an external and an internal, and sometimes into three.

The internal branch, the *posterior artery of the septum of the nose* (*A. septi narium posterior*), descends along the posterior part of the septum of the nose, sends ramuscules to the upper part of the pharynx, and penetrates into the posterior cellules of the ethmoid bone, and also into the upper turbinated bone.

The external branch descends along the outer edge of the posterior opening of the nasal fossæ, and usually divides into two ramuscules, which go, the upper to the middle, and the lower to the lower turbinated bone. These ramuscules are distributed principally in the posterior part of the nasal fossa and of the maxillary sinus.

II. INTERNAL CAROTID ARTERY.

§ 1360. The *internal carotid* or *anterior cerebral* artery (*A. carotis interna*, s. *cerebralis*, s. *cerebralis anterior*, s. *encephalica*) is usually smaller than the external, ascends behind it, before the internal jugular vein, on the outside of the pneumo-gastric nerve, directly before the vertebral column, to the lower orifice of the carotid canal. It does not generally bend much, although it is sometimes very tortuous, and it is rarely straight.

It seldom gives off branches in this course. It rarely in fact furnishes one of the internal or posterior branches of the external carotid or of the occipital artery. The latter comes from them less frequently than the others. Upward it gives off sometimes a small branch, which goes to the palatine region and to the velum palati.

Immediately below its entrance into the carotid canal it is generally almost horizontal, or at least goes obliquely upward and forward. At the lower part of this canal it goes vertically upward. It afterwards goes forward at nearly a right angle, and becomes almost horizontal, although it ascends a little. After leaving the canal it resumes its primitive direction upward, but proceeds at the same time forward and inward, and thus comes on the side of the sella turcica. At the posterior part of this excavation it curves a second time at a right angle, goes horizontally in the lateral carotid groove, going outward and a little downward. In this part of its course it accompanies the cavernous sinus of the dura mater, both being inclosed in the same portion of the dura mater, but separated by its proper membrane from the blood which it contains. At the anterior extremity of the lateral face of the sella turcica, below the anterior clinoid process, it describes a third right angle, and goes upward, backward and inward. In its course it gives off very trifling branches to the internal ear, to the dura mater, and to the third, fourth, fifth, and sixth pairs of nerves. Opposite the internal extremity of the upper orbitar fissure it divides into two branches, the continuation of the trunk which goes to the brain, and the ophthalmic artery.

Thus it changes its direction five times at least, and this arrangement retards the course of the blood much more, inasmuch as all the curves are sudden and do not occur on the same plane.

The internal carotid artery is intimately united by a very short cellular tissue to the canal through which it passes and which it almost entirely fills.

I. OPHTHALMIC ARTERY.

§ 1361. The *ophthalmic* artery (*A. ophthalmica*) is a very considerable branch, which exceeds in volume all those hitherto mentioned. It is always single. It leaves the skull through the optic foramen, usually on the outer and lower side, rarely at the upper part of the optic nerve, penetrates into the orbit, sends numerous branches to the parts of the eye, and also larger or smaller branches into the nasal fossæ and the face.

Having come into the cavity of the orbit, it soon ascends on the optic nerve, goes upward and inward, passes between this nerve and the rectus superior muscle of the eye, and thus arrives at the inner part of the orbit and goes forward to the internal angle of the eye.

Its branches vary surprisingly in respect to their origins, their number, and their volume. The principal are:

1st. Usually but not always an *external posterior ciliary* artery (*A. ciliaris posterior*), which arises from the outer side of the ophthalmic artery, goes forward and along the optic nerve on its outer and lower side, and penetrates the sclerotica directly before the anterior extremity of this nerve.

2nd. The *lacrymal* artery (*A. lacrymalis*) arises from the upper part of the ophthalmic artery, generally far backward and sometimes very far forward. It rarely arises from the middle meningeal artery, in which case it enters into the orbit, through the upper orbicular fissure, or through a special opening either in the malar bone or in the large wing of the sphenoid bone. It proceeds outwardly under the rectus superior muscle, to which it gives branches, and also to the rectus externus and to the levator palpebrarum muscles. It sometimes sends several through the malar bone into the temporal muscle, where they anastomose with those of the deep temporal artery. In some subjects one or several ciliary arteries arise from it. It then passes across, above or below the lacrymal gland, leaves the orbit at the external angle of the eye, anastomoses with the palpebral artery given off by the ophthalmic artery to form the palpebral arch, and terminates in the orbicularis palpebrarum muscle, the skin of the eyelids, and the tunica conjunctiva.

3rd. The *posterior upper ciliary* artery (*A. ciliaris posterior, superior*), is distributed in the same manner as the external, but gives off no branch after passing through the tunica sclerotica. Sometimes all the posterior ciliary arteries arise after the posterior ethmoidal artery; but they always proceed very tortuously on the surface of the optic nerve, and after dividing into numerous branches, pass through the posterior part of the sclerotica to enter the eye, where they are distributed in the manner stated in describing that organ.

4th. Next, a small inconstant branch arises and goes to the posterior part of the rectus superior muscle.

5th. The *posterior* or *middle ethmoidal* artery (*A. ethmoidalis posterior*, s. *media*) is also inconstant, and often arises from the lacrymal artery, from the anterior ethmoidal, or from the supra-orbitar artery.*

It gives first branches to the origin of the obliquus superior, rectus internus and externus muscles, then goes inward over the obliquus superior muscle, passes through the ethmoidal or posterior internal orbitar foramen, comes into the nasal fossæ, and is distributed to the posterior ethmoidal cellules, the sphenoidal sinus, and the antrum Highmorianum; it anastomoses with the branches of the posterior nasal or spheno-palatine artery and with the anterior ethmoidal artery, then re-enters the skull through a small canal in the ethmoid bone gives ramuscules to the periosteum which covers the anterior and, central fossa of the base of the skull, and terminates by again passing into the nasal fossæ through the openings in the cribriform plate.

6th. The *central artery of the retina* (*A. centralis retinæ*), arises farther back, directly from the ophthalmic artery, or from the preceding, or from the lacrymal artery, or from one of the two muscular branches;

* But it is not always the smallest, as Bichat asserts; we have remarked several times that it was one of the largest branches and much larger than the anterior.

it goes into the optic nerve, proceeds forward along its axis, and distributes itself to the retina, as we shall mention in describing the eye.

7th. The *inferior muscular* artery (*A. muscularis inferior*), is a considerable and rather constant branch, which sometimes gives off the central artery of the retina and one or more of the ciliary arteries, goes inward, sends branches to the rectus internus and inferior muscles of the eye, and penetrates even into the nasal fossæ.

8th. The *superior muscular* or *supra-orbitar* artery (*A. muscularis superior*, s. *supra-orbitaria*) is less constant than the preceding, but it comes from the lachrymal less frequently than from the ophthalmic artery. It proceeds forward directly below the orbitar plate, leaves the orbit through the supra-orbitar foramen, gives off branches to the frontal bone, to its periosteum, to the supraciliaris and orbicularis palpebrarum muscles, and to the skin of the forehead, and anastomoses with the other branches of the ophthalmic and with the temporal artery.

The *anterior ciliary* arteries (*A. ciliares anticæ*) arise from this branch and from the preceding; they divide into fewer branches than the posterior, and enter the sclerotica much farther forward than the latter, near the transparent cornea.

The branches we have described generally arise near the floor of the orbit, not far from each other; hence why they are generally long. After giving them off, the opthalmic artery is usually smaller and proceeds along the internal wall of the orbit, describing numerous curves. Towards the anterior opening of the orbitar cavity it gives off.

9th. The *anterior ethmoidal* artery (*A. ethmoidalis anterior*), which goes directly inward, passing over the obliquus superior muscle, and penetrates through the ethmoidal or anterior internal orbitar foramen into the nasal cavity, where it is distributed to the anterior ethmoidal cells and the frontal sinuses, and anastomoses with the other nasal arteries. It also sends off branches to the anterior region of the dura mater.

The ophthalmic artery now proceeds a short distance within the orbit, afterwards leaves this cavity at the inner angle of the eye, and terminates in giving origin to,

10th. The *palpebral* arteries (*A. palpebrales*). These arise sometimes by a common trunk (*palpebralis communis*) and sometimes separately, the superior a little before the inferior, and go outwardly. They are distributed partly to the conjunctiva, partly and particularly to the eyelids, in which they disappear between the skin and the orbicularis muscle. They divide there principally into two branches, one of which proceeds near the edge (*ramus marginalis*), while the other goes obliquely outward along the base of the eyelid.

The superior palpebral artery anastomoses in this place wth the lachrymal, the superciliary branch of the frontal, and even some branches of the anterior temporal artery. It also forms a single or double *superior palpebral arch* (*arcus tarseus superior*), which communicate with each other by numerous ramuscules, and thus form a network.

The *inferior palpebral arch* (*arcus tarseus inferior*) is produced in the same manner, by the anastomosis of the inferior palpebral with the infra-orbitar, the lachrymal and the nasal arteries.

All the parts of the eyelids are abundantly provided with vessels by these arterial branches.

11th. The *frontal* artery (*A. frontalis*), which also ascends soon after arising, usually divides immediately into three branches, the *supraciliary* artery (*A. supraciliaris*), the *superficial* or *subcutaneous frontal* artery (*A. frontalis subcutanea*), and the *deep frontal* artery (*A. frontalis profunda*). By this division it is distributed, 1st, to the upper part of the orbicularis palpebrarum and corrugator supercilii muscles; 2nd, to the frontalis muscle and to the skin of the forehead; 3rd, to the frontal sinus. It extends to the coronal suture and to the temporal region, where it anastomoses with the branches of the external temporal artery; it also communicates in other parts with those of the supra-orbitar and lachrymal arteries.

12th. The *nasal* artery (*A. nasalis*) varies much in volume. Sometimes it is a very small branch, terminating at the root of the nose; sometimes it forms the continuation of the trunk of the ophthalmic artery, descends very low, contributes with the lateral nasal branch of the facial artery to produce the dorsal artery of the nose, extends to the end of the nose, proceeding on the side of this organ, always anastomoses with the inferior palpebral and the facial artery, and gives ramuscules to the integuments and to the nasal bones, to the frontalis muscle, to the internal part of the orbicularis palpebrarum, to the muscles of the nose, and even to the pituitary membrane.

II. CEREBRAL ARTERIES.

§ 1362. After giving off the ophthalmic artery, the internal carotid artery is distributed entirely to the cerebrum, particularly to its anterior portion, the posterior being supplied with blood from the vertebral artery. It properly deserves then to be called, from this point, the *anterior cerebral* artery (*A. cerebralis anterior*).

§ 1363. It gives off, first, small ramuscules, which go inward, and are designed for the posterior part of the optic nerve, for the infundibulum, for the pituitary gland, and for the third ventricle.

§ 1364. It then gives off four branches; these are the *communicating* artery, the *choroid* artery, the *anterior cerebral* artery, and the artery of the *corpus callosum*. The first two generally arise directly after each other; and the carotid artery bifurcates farther on to give rise to the last two. Sometimes, but more rarely, three or all of these branches arise from the same point.

§ 1365. The first, or the *posterior communicating* artery (*A. communicans posterior*), goes backward and inward. It approaches that of the opposite side, opens into the posterior cerebral, which comes from the vertebral, artery, or if we prefer it anastomoses with a branch analogous to it, which it meets.

This anastomosis gives rise to the posterior part of the *circle of Willis* (*circulus Willissii*).

The size of this communicating artery varies extremely. It is generally considerable, and only about one half smaller than one of the succeeding branches, into which the internal carotid artery divides. It is sometimes however very small; in this case the anastomosis between the internal carotid and the vertebral artery, frequently but not always takes place by means of another and larger branch of the anterior cerebral artery, which opens more outward into the posterior. The communicating artery is sometimes larger on one side than on the other.

Sometimes this artery is a branch of the anterior cerebral.* It arises more rarely not from this but directly from the basilar artery, when the posterior cerebral artery does not come from it, and it is given off by the internal carotid.

But the anastomosis almost always exists; and it is constantly simple or at most double, on each side, when it occurs by considerable branches, although we find others which are accessory and smaller in the cerebral peduncles.

We consider its total absence as one of the rarest anomalies. We have never yet seen it, and Barclay alone mentions one case where the injection penetrated neither from the carotid into the vertebral artery, nor from the vertebral into the carotid.†

Several vessels arise from the communicating artery and go to the pia-mater or to the floor of the third ventricle, to the mamillary eminences, to the posterior part of the optic nerves, to the thalami optici, to the cerebral peduncles, to the inner face of the anterior part of the large cerebral lobe, and to the choroid plexuses.

§ 1366. *b.* Above the communicating artery, the internal carotid always gives off a special branch, the *choroid* artery (*A. choroidea*) which also arises from its posterior part.‡ This artery goes a little backward and outward, along the posterior edge of the origin of the optic nerve, ascends above the upper part of the cerebral peduncle, and expands partly in the pia-mater of the anterior part of the pos-

* This anomaly, however, is proportionally very rare. Portal then estimates incorrectly, the relation between the rule and the exception, in saying that the internal carotid artery usually divides into two branches, the smaller of which is the artery of the corpus callosum, the larger the anterior lobate artery; the latter giving off the communicating artery, which sometimes arises directly from the internal carotid. Hilderbrandt seems to think that the two cases are equally frequent which is just as false.

† *Loc. cit.*, p. 47.

‡ We have always found this branch very constant, although several anatomists particularly Mayer, Murray, Portal, Hilderbrandt, and Sœmmerring, do not mention it. Haller states (*Ic. anat.*, vol. vii. p. 5) that it *sometimes* exists. Sabatier, Boyer, and Bichat assert that it is *constant*, which agrees with our remark. But Bichat errs in saying that the choroid is *always* smaller than the communicating artery. This case frequently occurs, since, as we have observed, the communicating artery is usually large; but we have often found, when this was small, that the choroid artery was as large or even larger than it.

terior cerebral lobe and of the thalami optici, and partly also penetrates through the anterior opening of the lateral ventricle, into this cavity, where its ramifications expand in the choroid plexus.

§ 1367. The internal carotid now divides, at a very obtuse angle and at the anterior extremity of the fissure of Sylvius, into two unequal branches; these are the artery of the corpus callosum and the anterior cerebral artery.

§ 1368. The artery of the *corpus callosum* (*A. callosa*, s. *corporis callosi*, s. *anterior cerebrica*, s. *anterior hemisphæri*, s. *mesolobica*) is always smaller than the posterior branch. It goes forward and inward, directly before the union of the optic nerves, proceeds to meet that of the opposite side, towards which it converges very much, and after giving off superiorly generally several ramuscules for the posterior extremity of the anterior lobe, for the olfactory and for the optic nerves, it anastomoses with it between the posterior extremities of the first two lobes by the *anterior communicating* artery (*A. anterior communicans*, s. *anastomotica*). This branch is generally very short; sometimes, however, it is three or four lines long; it is generally much larger in the former case and often very narrow in the second. Its direction is always transverse. Sometimes it is entirely double; and we not unfrequently find it double in one half its extent.* It gives off, particularly when longer than usual, ramuscules, which go upward and backward, into the septum lucidum, the fornix, and the corpus callosum.

The trunk also generally sends off one or more small branches which proceed forward and outward to the inner part of the inferior face of the anterior lobe of the cerebrum. After this, it is situated directly near that of the opposite side, turns on the anterior extremity of the corpus callosum, ascends to the inner face of the cerebral hemispheres, and divides into several branches, the anterior of which enter into the circumvolutions of this internal face, while the posterior proceed on the corpus callosum, as far as its posterior extremity, where they begin to change their direction and to go upward. All these branches extend to the upper face of the cerebrum and anastomose with those of the succeeding artery, and with those of the posterior cerebral artery, given off by the vertebral artery.

Besides these large branches, into which the artery of the corpus callosum divides above, it also gives off, from its lower and concave part, numerous smaller branches, which distribute themselves in the corpus callosum.

Rarely, a large posterior branch is detached on both sides at the place where the two arteries of the corpus callosum meet, and the anterior anastomosing branch becomes the single trunk of the anterior part of the artery of the corpus callosum, which shortly divides into two large branches, a right and a left, or the two arteries arise from

* Bichat is incorrect in stating that this arrangement is very rare.

a common trunk, and do not give off a branch posteriorly. This arrangement is remarkable because of the analogy it establishes with the union of the two vertebral arteries into one, the basilar, which is situated on the median line.

§ 1369. The *anterior* or more properly the *middle cerebral* artery (*A. cerebri anterior*, s. *media*, s. *hemisphærica media*, s. *fossæ Sylvii*, s. *sylviana*), the last and the most posterior branch of the internal carotid, is always much larger than the preceding. Soon after its origin it goes outward, and only a little inward; it enters the fissure of Sylvius, gives off, at its upper and posterior part, numerous, generally small, ramuscules, some of which penetrate into the anterior extremity of the posterior lobe, others into the posterior extremity of the anterior lobe, and afterward divides generally about half an inch from its origin into two, three, or four large branches. The largest of the latter are turned backward, soon bifurcate, and proceed, closely against each other, into the bottom of the fissure of Sylvius, where they go upward and backward. The anterior attain the posterior and external part of the anterior lobe, and the posterior the anterior central part of the posterior lobe, gliding in the circumvolutions of the posterior face of the first and the anterior face of the second, but penetrating mostly into their substance, through their outer face, and thus extend to the upper edges of the hemispheres, where they anastomose with the ascending branches of the anterior and posterior cerebral arteries.

§ 1370. The anterior and middle cerebral arteries are not always arranged symmetrically. The two large middle arteries not unfrequently arise (as Haller states and as we have verified) from the right carotid only, and the anterior, which is smaller, from the left carotid, an arrangement which deserves to be remarked as indicating the predominance of the right side over the left.

Sometimes also only the left anterior artery comes from the internal carotid of the same side, and the other three come from the right. We have seen this anomaly in several subjects.

If we add the union of the arteries of the corpus callosum at their origin, which we mentioned above, we here find a remarkable repetition of several of the varieties to which the origins of the trunks coming from the arch of the aorta are subject.

ARTICLE FOURTH.

ARTERIES OF THE UPPER EXTREMITIES.

§ 1371. The arteries of the upper extremities, for which we cannot find a better term than that of the *brachial* arteries* (*A. brachiales*),

* This term is generally applied only to that portion of the artery which corresponds to the arm, and which might more properly be termed the *humeral* artery.

arise on each side by a single trunk, generally called the *subclavian* artery (*A. subclavia*).

I. SUBCLAVIAN ARTERY.

§ 1372. The two *subclavian* arteries (*A. subclavia*) arise from the ascending aorta, and extend to the scaleni muscles. They differ in their mode of origin; for the left subclavian artery arises directly from the arch of the aorta, while the right proceeds indirectly from it, as it is the external branch of the trunk of the innominata (*truncus communis innominatus*), which bifurcates and gives origin to it and to the right primitive carotid.

This at least is the most common arrangement. Sometimes, but rarely, the subclavian arteries arise directly from the arch of the aorta. We may there find two principal differences. Sometimes in fact the trunk of the innominata gives off the right subclavian and the carotid, the subclavian artery arising on the right, outside of the carotid, which is the least but also the rarest anomaly. Sometimes the right subclavian artery arises more to the left, until it is the extreme left trunk of those which arise from the arch of the aorta, below the left subclavian artery, and goes to the right, towards the corresponding limb, passing behind the other trunks, rarely directly, more frequently between the trachea and the esophagus, and still more frequently between the esophagus and the vertebral column.

§ 1373. The first branches of the subclavian artery are never constant. They often and in fact almost always arise from its upper extremity, directly before its passage between the scaleni muscles. But sometimes the artery gives off much sooner, and even near its origin, considerable branches, which go to the thymus gland, to the upper part of the pericardium, also to the trachea, to the bronchiæ, and to the esophagus (*A. thymicæ, pericardiacæ superior, anterior et posterior, bronchiæ, œsophageæ, broncho-œsophageæ*), but they rarely or never belong to these parts alone, although they distribute branches to all. Even when these branches arise from the subclavian artery (which occurs on the left side more frequently than on the right, because it descends deeper) its course is no shorter, but it gives off no branch until just before passing between the scaleni muscles. Here, however, several large branches arise from it. These may be distinguished generally speaking into the *upper* or *posterior* and the *lower* or *anterior* branches; and they vary much, for, 1st, the same twigs do not always arise from the same branches, so that the latter are not always of the same calibre; 2nd, small branches sometimes arise from the subclavian artery, by a common trunk, whence their number varies; 3rd, they do not always emerge from the same point of the subclavian artery, the inferior arising sometimes farther forward, and the superior farther backward than usual.

A. UPPER POSTERIOR BRANCHES.

§ 1374. The most constant of the upper and posterior branches are two, the *vertebral* artery and the *inferior thyroid* artery.

I. VERTEBRAL ARTERY.

§ 1375. The *vertebral* artery (*A. vertebralis*) is generally the first and largest of the two upper branches of the subclavian artery. Shortly after arising, it enters the arterial canal of the cervical vertebræ, and goes from below upward. This artery shows a great disposition to change its origin, and to arise directly from the arch of the aorta. We shall remark, 1st, that this anomaly, however common it may be, is seldom seen on the right side (at least to our knowledge), and that it rests always on the left;* 2nd, that when it occurs, the vertebral artery is almost always inserted between the left carotid and the left subclavian arteries. If this branch arises directly from the arch of the aorta more frequently than the others, it may be attributed, we think, to the following facts: 1st, in the normal state it is the first branch of the subclavian artery; 2nd, the vertebral vein normally empties itself into the common trunk of the subclavian and jugular veins. The other fact, that the anomaly appears almost entirely on the left side, seems to us to depend on this, that the division of the trunk into branches characterizes the left side of the ascending aorta even in the normal state, since the subclavian arteries there arise separately, and are not blended in a single trunk, as on the right side. The greater length of the left trunk of the innominata vein may contribute to it, since this anomaly should be considered, as we have remarked, an imitation of the arrangement of the venous system. Finally, the situation of this artery between the left carotid and the left subclavian arteries probably depends on its arising, in the normal state, from the internal and posterior side of the subclavian artery.

We sometimes but rarely find on the right side a similar anomaly where the vertebral artery arises from the bifurcation of the trunk of the innominata; this is still more curious, because in comparing this arrangement with that on the left side we have a new proof that the anomaly does not destroy in the two sides the character of the normal type.

We know of only one case where the right vertebral artery arose from the arch of the aorta; but that of the left side also presented the same anomaly.

* This might be easily proved by numerous quotations. Of all the authors who mention this variety Mayer is the only one who asserts the contrary; for, without speaking of the left vertebral artery, he asserts only that the right sometimes arises directly from the arch of the aorta. This assertion is so contradictory to observation that it can be explained only by considering it as a typographical error.

A second anomaly of the vertebral artery consists in its division into several trunks. Sometimes then one of the trunks arises directly from the arch of the aorta; the other, which is generally smaller, from its usual place;* or both come from the subclavian artery, at a greater or less distance from each other. Perhaps the first arrangement also is found only on the left side; at least in a specimen before us, and where the anomaly exists on the right, the two vertebral arteries are branches of the subclavian artery. In both cases one of the trunks, particularly the largest, enters the vertebral canal higher than usual. Sometimes it unites with the other, which enters at the normal place; sometimes it unites with it before entering this canal; sometimes, finally, the smallest branch extends into the vertebral canal after passing over one or more vertebral foramina.

Even when the vertebral artery is normal in respect to its origin, it enters the vertebral canal at several different points. Its proper place is the vertebral foramen of the sixth cervical vertebra.†

In extremely rare cases this artery enters through the vertebral foramen of the seventh cervical vertebra.‡ Even when it arises lower than usual, from the arch of the aorta it however enters into the hole of the sixth cervical vertebra, and we have frequently seen it in this case not enter the vertebral canal until it reaches the fifth vertebra.

More frequently, although not very often, the vertebral artery, even if not double, enters through the vertebral foramen of the fifth, fourth, third, or even the second cervical vertebra. We know of no case in which it has been found entirely out of the vertebral canal, and we have never known it to leave this channel lower than the upper vertebra, or to leave a vertebra, pass through a certain extent on the anterior face of the transverse processes, and enter again into the vertebral canal.

Finally, the vertebral artery of one side is very frequently much larger than that of the other, although according to our observations the sides of the body have no effect on this disproportion.

This anomaly confirms the general rule that the synonymous arteries which go to the single organs on the median line of the body often differ in volume and enlarge on one side at the expense of the other.

* Henkel, *Anmerkungen von weidernatürlichen Geburten, zweite Sammlung*, p. 10, 11.—Huber, *De arcus aortæ ramis*; in the *Act. Helv.*, vol. viii. p. 68-102.

† We have always observed this, except in a very few instances. Haller (*Ic. anat. fasc.* ii., *explic. icon.* 2, *art. thyr. infer.*, *not.* c) and Sœmmerring (p. 177) are then correct in saying that this arrangement is normal. Mayer mistakes in saying (p. 110) that there is for the vertebral artery a special opening, through which it enters into the vertebral canal, sometimes in the seventh and sometimes only in the sixth cervical vertebra. This opening always exists except in a very few instances in the seventh cervical vertebra; but the vertebral artery rarely or never passes through it and always enters through the sixth. What Mayer considers the normal state is a rare anomaly, and *vice versâ*. Monro (*Outlines &c.*, vol. iii. p. 301) is also mistaken in thinking that the artery enters through the seventh cervical vertebra as often as it does through the sixth.

‡ Bichat (p. 193) is correct in saying that it sometimes but rarely enters through a similar foramen of the seventh cervical vertebra. This arrangement is rare, as Haller, Murray, and Sœmmerring have not spoken of it, although they mention the next.

§ 1376. The vertebral artery ascends in an almost straight line to the second cervical vertebra; but at this point it becomes tortuous and describes several curves, four of which are very remarkable. First, it penetrates into that part of the canal which belongs to the transverse process of the second vertebra, forming a right angle, assuming an entirely horizontal direction, and going transversely outward; then passing through this opening, it describes another right, acute, or obtuse angle, resumes its first direction, and becomes perpendicular again at the upper cervical vertebra. When it has passed through the vertebral foramen it inclines again at a right angle, resumes a second time a horizontal direction, and goes backward and inward, turning around on the articular process of the first cervical vertebra, along its posterior groove. From the posterior extremity of the articular process it goes gradually and at an obtuse angle inward and upward, and soon enters the cranium, passing through the dura mater and the large occipital foramen directly above the occipital condyle. Having entered the skull, it is situated first on the side, then on the lower face of the medulla oblongata, and ascends forward and inward on the basilar process of the occipital bone. There the two arteries approach each other, and after passing usually more than an inch within the cavity of the skull, they unite at an acute angle, either a short distance behind the posterior edge of the pons Varolii, or on this edge, or even in its centre. They always, as far as we know, unite and give origin to a single trunk, the *basilar* artery (*A. basilaris*), which is much smaller than the two branches which produce it. In size it nearly equals the internal carotid artery after it gives off the ophthalmic artery. It proceeds forward to the centre of the lower face of the pons Varolii, and divides at its anterior extremity into two large branches, a right and a left.

§ 1377. In this course the vertebral artery generally gives off no branches, or at least but small and inconstant ones. These branches are distributed to the anterior deep muscles of the neck. In this respect the vertebral artery resembles the internal carotid.

§ 1378. From the portion within the vertebral canal several small branches pass forward, outward, and backward, generally between every two vertebræ, and go to the vertebræ, to the intertransversarii, to the multifidus spinæ, to the anterior deep muscles of the neck, and to the small muscles of the head.

Internal branches, which are also very small, pass through the intervertebral foramina, either alone or attended with small arterial twigs from the other branches of the subclavian artery, penetrate the vertebral canal and are distributed partly to the nerves, others to the anterior and posterior sides of the dura mater and to the pia mater of the spinal marrow. They anastomose with those of the opposite side and with the anterior and posterior spinal arteries.

Considerable branches arise from that part of the vertebral artery between the first and the second cervical vertebræ, and also between the latter and the occipital bone. Some go outward, are expanded in the

transversalis colli and the complexus minor muscles, and anastomose with the branches of the ascending cervical artery, and sometimes entirely replace it. The others proceed backward and outward and are distributed in the posterior and lateral small muscles of the head. Some go inward and anastomose with the synonymous branches of the other side. Finally, many enter the tissue of the dura mater.

§ 1379. The largest branches arise from that part of the vertebral artery within the skull. From the difference of calibre between the branches which it sends out of the cavity of the skull, this part is frequently much larger on one side than on the other, although both have primarily the same diameter at their origin, and although the side of the body has no necessary influence upon this difference.

The branches which arise before the two vertebral arteries unite are the *anterior spinal* artery, the *posterior spinal* artery, and the *inferior artery of the cerebellum.*

§ 1380. The *posterior spinal* artery (*A. spinalis posterior*) is the smallest, and often comes from the inferior artery of the cerebellum. It arises the lowest and from the outside of the vertebral artery, goes inward on the posterior face of the spinal marrow, and descends on each side along the posterior spinal groove to the end of the spinal marrow. The two arteries are very tortuous and are parallel to each other. They are always enlarged by the accessory ramuscules of the vertebral, the deep cervical, and the intercostal arteries which pass through the intervertebral foramina, and anastomose by numerous transverse branches, which generally correspond to the intervertebral spaces; so that each portion of the spinal marrow between two vertebræ has its special vascular circle, even as the four cerebral arteries form one by their anastomoses.

§ 1381. The *inferior artery of the cerebellum* (*A. inferior cerebelli*) also arises from the outer side of the vertebral artery and is usually double on both sides.

One, the *posterior inferior* artery of the cerebellum, arises farther backward, and goes backward, upward, and inward, proceeds on the lateral parts of the medulla oblongata, distributes its branches to the tela choroidea of the cerebellum and to the floor of the fourth ventricle, and ascends between its two hemispheres to its vermiform eminence and to the inner face of its two hemispheres. This branch often exists on one side only, and then it is observed particularly when the inferior artery of the cerebellum arises very far forward.

The *anterior inferior* artery of the cerebellum sometimes arises at the origin, sometimes also at the extremity of that portion of the vertebral artery within the skull. In some subjects, particularly when the vertebral arteries unite early, it comes from the basilar artery. These varieties are observed even on both sides of the body at once. The anterior inferior artery of the cerebellum not only frequently exists alone but it is generally much larger than the posterior. It is sometimes much smaller on one side than on the other. It proceeds very

tortuously outward and backward to the lower face of the cerebellum, where it passes on the grooves which it crosses and divides into branches, some of which go backward and others forward. These branches also cross the direction of the grooves of the cerebellum; the small ramifications alone become parallel and finally penetrate into them.

§ 1382. The *anterior spinal* artery (*A. spinalis anterior*) generally commences a short distance from the lower edge of the pons Varolii, even when the two vertebral arteries unite much higher than usual. It arises from the internal part of the trunk and soon unites with that of the opposite side in a single trunk on the median line, which descends along the anterior groove of the spinal marrow. Generally, particularly when the two vertebral arteries unite higher than usual, we find a small anterior and superior spinal artery, which is sometimes single and arises from the top of the angle of union, and sometimes double, which blends likewise with that of the opposite side, and which, proceeding also from above downward, soon anastomoses with the lower. The single trunk of the latter, which corresponds to the median line, is often divided in its course and thus forms considerable islands. Its upper part receives also from all or most of the intervertebral foramina considerable branches, which are given off by the vertebral or the other cervical arteries to the anterior face of the spinal marrow and anastomose with it. During its course, which is very tortuous, it sends off on each side numerous branches to the spinal marrow.

II. BASILAR ARTERY.

§ 1383. The *basilar* artery (*A. basilaris*. s. *meso-cephalica*) is constant, and arises, proceeds, and varies in the manner mentioned above. We however sometimes remark in its arrangement a tendency to a want of union or to the separation of the vertebral arteries, since it forms islands, especially at its posterior part. This artery is however the only one in which we have observed this arrangement. It very soon divides into two parts, which almost immediately unite. We consider this anomaly as very rare, not only because we have never seen it but twice, but because it is not mentioned by the most correct angeiologists.* It is curious not only as an anomaly, but because it increases the analogy between the basilar and the anterior spinal arteries, which are already so similar. It is not unimportant to say, that in the two subjects which presented this unusual arrangement the anterior communicating artery of the two internal carotids pre-

* An arrangement has been figured by Heuermann (*Physiologie*, vol. ii. tab. 8) where the two vertebral arteries were connected behind their union by a large transverse branch, to give rise to the basilar artery, which seems to have some relation with this anomaly; but more probably it consisted only in the union of the anterior spinal arteries, since the two vertebral arteries are not yet united behind this branch.

sented analogous divisions. In the latter however this anomaly is much more common than in the basilar artery.

From both sides of the basilar artery numerous branches arise, generally at right but sometimes at angles slightly acute, backward, which vary much in number and volume and do not correspond perfectly on both sides. The smallest enter into the pons Varolii and the nerves which come from it; the largest, even when the usual inferior arteries of the cerebellum do not exist, proceed even to the lower face of the cerebellum.

Some branches, the *internal auditory* arteries (*A. auditivæ internæ*), enter into the internal auditory foramen, expand in the labyrinth, and anastomose with the branches of the internal and of the external carotid arteries which enter into this organ.

§ 1384. At its anterior extremity, in the middle of the anterior edge of the pons Varolii, the basilar artery usually divides into four branches, two on each side, the superior artery of the cerebellum and the posterior cerebral artery.

§ 1385. The *superior artery of the cerebellum* (*A. cerebelli superior*) which is almost as large as the inferior, is rarely deficient on one side, in which case it is replaced by a branch of the following. It is more frequently double; and then the vertebral artery divides into five branches, of which the two superior arteries of the cerebellum are situated very near each other: sometimes but much more rarely, it arises some lines behind the anterior extremity of the vertebral artery. It goes transversely outward and upward, directly behind the anterior edge of the pons Varolii, then proceeds a little backward, turns upon the pons Varolii to arrive at the anterior edge of the cerebellum, and divides into superficial and deep branches. The first proceed backward on the ridge of the cerebellum to its posterior edge, where they anastomose with the branches of the inferior artery of the cerebellum; the others penetrate upward into the anterior lobes.

§ 1386. The two anterior branches, the *posterior* or *deep cerebral* arteries, *Lobaires postérieures du cerveau*, Ch. (*A. cerebri posteriores*, s. *profundæ*), are much larger than the superior arteries of the cerebellum. They arrive at an acute angle, separate much from each other and go forward and outward. They usually give off near their origin and at their upper and external part several branches, some of which are considerable and go to the cerebral peduncles, to the thalami optici, to the tubercula quadrigemina, and to the valve of Vieussens. After proceeding a short distance they divide into two branches, the communicating artery and the continuation of the trunk.

The *communicating* artery is situated inward, and is smaller than the other. Its direction is outward and forward and it proceeds to meet the anastomosing branch of the internal carotid artery, with which it unites.

The continuation of the trunk of the posterior cerebral artery, which is usually the smallest of the three proper cerebral arteries, sometimes

arises from the internal carotid artery, previous to its bifurcation, and sometimes also from the union of the anastomosing branches given off by the internal carotid and the vertebral arteries. It goes outward and upward, before the third pair of the cerebral nerves, and turns on the cerebral peduncle, to the lower face of which it gives some ramuscules, which thus arrive at the thalami optici and the tubercula quadrigemina, penetrate into the third ventricle, and are distributed principally to the choroid plexus. Finally, it goes on one side to the posterior part of the cerebrum and of the corpus callosum, and also to the thalami optici on the other, particularly to the lower face of the cerebral hemispheres. It anastomoses very frequently with the anterior or central arteries and with the arteries of the corpus callosum, which arise from the internal carotid artery.

§ 1387. The peculiarities presented by the arteries of the brain have been described before or will be mentioned when we speak of the encephalon.

III INFERIOR THYROID ARTERY.

§ 1388. The *inferior thyroid* artery (*A. thyroidea inferior*, s. *sacro-thyroidea*, *Barclay*) arises from the subclavian artery, more outward and forward than the vertebral artery, from which however it is not always the same distance. It most generally gives off the inferior thyroid branch and several twigs, which go to the muscles and to the skin of the neck, the back, and the shoulder.

This artery is large, particularly in the child, where it is equal to the subclavian or even the carotid artery. Its size however varies much, because that one or more branches which it commonly furnishes frequently arise from other trunks, but the arteries which generally come directly from the subclavian artery are rarely given off by it. This is true for instance of the internal mammary artery, and the former is true in regard to the branches which go to the muscles of the neck, shoulder and back. Sometimes it goes only to the thyroid gland. In other cases it is uncommonly large, because it gives off not only the usual branches but also the internal mammary artery. In rare cases, on the contrary, it does not deserve its name, because it gives branches only to the muscles and the inferior thyroid arises from the common carotid artery, or does not exist as a separate vessel, but is blended with the superior thyroid artery. This anomaly is curious, as it is a repetition of the normal formation of most mammalia.

Another and somewhat similar anomaly is when the inferior thyroid artery is uncommonly small, either on one or both sides, and one or both of the superior thyroid arteries are larger in the same proportion, or finally when beside the two common thyroid arteries, there is also a third (*A. thyroidea ima*, s. *Neubaueri*), which arises lower down either from the arch of the aorta on the right of the left carotid or from the common trunk of the carotid and the subclavian artery, when the

anomaly occurs on the right side, or from the common trunk of the carotids of one side only, or finally from both sides at once, sometimes higher and sometimes lower.

We must also mention here the rare anomaly where the inferior thyroid artery is totally deficient on one side, while on the other, in the usual place, particularly on the right, instead of the two inferior thyroid arteries, we have a common trunk,* which arises sometimes from the aorta and sometimes from its usual place. We have twice observed a case resembling this, where the inferior thyroid artery rose from the arch of the aorta, between the trunk of the innominata and the left carotid arteries.

IV. SUPERIOR SCAPULAR ARTERY.

§ 1389. In most cases the inferior thyroid artery, immediately after arising, gives off the *superior scapular* artery (*R. transversus scapulæ*, s. *scapularis transversa*, s. *scapularis superior*, s. *cervicalis superficialis*), which however sometimes arises from the subclavian artery, sometimes singly, and sometimes by a common trunk with the following. It goes transversely backward and outward behind, and a little above the clavicle between the scalenus anticus and the scalenus medius; gives branches to the sterno-thyroideus, the sterno-hyoideus, the omohyoideus, the scaleni, the trapezius, and the supraspinatus muscles; passes between the spine and the glenoid cavity of the scapula, and enters the infraspinalis fossa. There it divides into several branches, the smallest of which usually pass through the semicircular notch to the anterior face of the scapula and to the subscapularis muscle, while the largest are distributed on the posterior face of this one, to which it gives one or more nutritious twigs, and terminates in the infraspinatus muscle. Another branch arises from this point and goes forward between the proper and common ligaments of the scapula, distributes itself in the articular capsule of the shoulder and in the upper and anterior part of the deltoides muscle, and anastomoses by several large branches with the anterior circumflex artery of the arm and with the great thoracic artery.

V. TRANSVERSE CERVICAL ARTERY.

§ 1390. The *transverse cervical* artery (*A. cervicalis superficialis*, s. *cervicalis transversa*, s. *colli transversa*), which is generally as large as the preceding, arises from the inferior thyroid artery, a little higher and at some distance from it outwardly; it often arises directly from the subclavian artery. It goes transversely outward and backward. It is situated at first on the side of and a little behind the superior scapular artery, and it gives off in this course branches to the scaleni

* Burns, *loc. cit*, p. 331.

muscles, and divides into two large branches on a level with the upper edge of the shoulder. The ascending branch becomes the principal branch of the trapezius and also sends some ramuscules to the levator scapulæ muscle ; the other descends along the base of the scapula between the rhomboidei and the serratus magnus muscles, in which course it gives off twigs to these muscles and also to the lower part of the trapezius muscle.

§ 1391. A little higher, one or more small branches (*R. thoracici*) arise very constantly from the inside of the inferior thyroid artery ; these go upward and inward to the lower part of the longus colli muscle, penetrate also the spinal canal through the intervertebral foramina, but go particularly to the trachea and to the esophagus. The latter are termed the *bronchial* and the *esophagœal* arteries (*A. branchiales, œsophageæ*, s. *broncho-œsophageæ*).

§ 1392. After passing through rather a long course upward without giving off any branch, the inferior thyroid artery divides into two branches, the ascending cervical artery, which is generally much smaller and goes upward and outward, and the thyroid artery, which may be considered as the proper continuation of the trunk.

VI. ASCENDING CERVICAL ARTERY.

§ 1393. The *ascending cervical* or the *superior dorsal* artery (*A. cervicalis ascendens*, s. *dorsalis suprema*) is a very constant branch of the inferior thyroid artery and sometimes but rarely arises from the subclavian artery; this happens particularly when the branches already described arise separately from the proper thyroid artery. Sometimes also it arises from the internal mammary artery. It ascends along the transverse processes of the cervical vertebræ, between the longus colli and the scaleni muscles. In its course it gives off backward, outward and upward several considerable branches, which are distributed in the upper part of the trapezius, the levator scapulæ, the serratus magnus, the serratus posticus, the scaleni, and the splenii muscles, and the skin of the neck : the trunk generally goes backward, below the transverse process of the third cervical vertebra, penetrates deeply between the transversalis colli and the complexus minor muscles, and having thus come upon the posterior face of the neck, it terminates in two principal branches ; the smaller ascends behind the transverse processes of the cervical vertebræ, gives ramuscules to the complexus minor muscle and to the posterior small muscles of the head, anastomoses with the vertebral and occipital arteries, and finally penetrates into the spinal canal between the first and second cervical vertebræ where it terminates in the dura mater. The other is larger and is the continuation of the trunk : it goes outward between the fasciculi of the complexus major muscle, and terminates in this muscle and in the digastricus and the posterior muscles of the head.

§ 1394. The *thyroid* branch (*R. thyroideus*) sometimes arises singly rom the subclavian artery, from the aorta, the innominata, or from he common carotid artery. It is sometimes entirely deficient in some ubjects, but is generally the largest branch of the inferior thyroid rtery. It is very tortuous and curves very much in ascending toward ie thyroid gland. It usually passes behind, sometimes but rarely efore, the primitive carotid, in order to arrive at this gland. Before aching it, it divides into several branches, which enter this organ rincipally on its lower edge and lower face and anastomose with ich other and with those of the superior thyroid artery.

The thyroid branch also gives in its course smaller ramuscules to ie longus colli muscle, to the pharynx, and particularly to the rynx. The latter is termed the *inferior laryngeal* artery (*A. laryngea ferior*).

VII. LOWEST THYROID ARTERY.

§ 1395. Besides the branch described (§ 1364), another branch lled the *lowest thyroid* artery (*A. thyroidea ima*) arises sometimes m the primitive carotid or from the innominata, from the arch of e aorta or from the subclavian artery, by a trunk in common with at of the opposite side.

This anomaly occurs on the right side more frequently than on the t side;* we have never observed it on the latter side, although we ve frequently seen it on the other. In one case only, where the igin of the inferior thyroid artery was abnormal, it did not arise from e left side of the arch of the aorta, but from the right side, between e innominata and the left carotid artery; thence it passed before the achea to go to the left side of the thyroid gland, while the origin and rection of the right was normal. This anomaly then seems properly belong to the right side, even as the similar anomaly of the verteal artery appears exclusively on the left side.

Finally, whether this abnormal artery forms a part or the whole of e inferior thyroid artery, whether it arises from the innominata, or m the arch of the aorta, or deeply from the primitive carotid artery, always passes on the anterior face of the trachea to go to the thyd gland, into which it enters from below upward. It cannot then ape being wounded in the operation of laryngotomy.

* We have found it nine times on the right. Hubert (*loc. cit.*, p. 84) has seen lowest thyroid artery arise four times from the common trunk, three times on right and only once on the left side. Neubauer has also seen the right com- from the aorta (in Erdmann, *Descrip. art. thyr. imæ*, Jena, 1772). Ramsay *ccount of an unusual conformation of some muscles and vessels*, in the *Edinb. d. and. Surg. Journ.*, vol. viii. p. 281-283, tab. 1, fig. 2) has found it arising from innominata trunk. Loder has twice seen it arising from the aorta, between right carotid and the subclavian arteries: the innominata trunk did not exist these two cases (*De nonnullis arteriarum varietatibus*, Jena, 1781).

VIII. DEEP CERVICAL ARTERY.

§ 1396. The *deep cervical* artery (*A. cervicalis profunda*) often form a special trunk, which arises from the back side of the subclavian artery, a little more externally than the preceding, but frequently by a common trunk with the superior intercostal artery. It is rarely given off by the inferior thyroid or even by the vertebral artery; in the latter case its origin is generally a little below that of the vertebral artery. It more rarely comes from the upper part of the latter, in which case it sometimes descends between the first cervical vertebra and the occipital bone, and is afterwards distributed as usual, but so that its lower branches are almost always supplied by the other branches of the subclavian artery.

It goes obliquely upward and outward, passes backward between the transverse processes of the sixth and seventh cervical vertebræ or the latter and the first dorsal vertebra. It ascends between the transversalis colli, the spinalis colli, and the semispinalis dorsi muscles on one side, and the digastricus and the complexus muscles on the other. It also distributes branches to the scaleni, the complexus minor, the cervicalis descendens, the trapezius, the splenii, and the small posterior muscles of the head, and anastomoses, especially above, near the occipital foramen, with the branches of the vertebral and occipital arteries. It also sends ramuscules into the spinal canal through the intervertebral foramina, which anastomose there with the spinal arteries given off by the vertebral artery.

B. INFERIOR BRANCHES.

§ 1397. The *inferior branches* of the subclavian artery are the internal mammary artery and the superior intercostal artery.

I. INTERNAL MAMMARY ARTERY.

§ 1398. The *internal mammary* artery (*A. mammaria interna*, s. *sternalis*, s. *substernalis*) is much smaller than the vertebral and the inferior thyroid arteries. It arises ordinarily and very constantly by a distinct trunk from the anterior or inferior side of the subclavian artery, nearly opposite the inferior thyroid artery. It however in some rare cases, one of which is now before us, arises by a common trunk with the latter, or on the right side from the innominata,* or even from the arch of the aorta.†

It generally goes downward and inward, but sometimes also ascends a little before taking this direction, which it long preserves. It

* Neubauer, *loc. cit.*, p. 33.

† Bœhmer, *De quat. et quinq. aortæ ram*; in Haller, *Collect. diss. anat.*, vol. iii p. 452.

descends almost in a straight line to the posterior face of the anterior wall of the chest, on the costal cartilages between the intercostales and the triangularis sterni muscles, nearer its internal than its external extremity, consequently not far from the two edges of the sternum, which it also approaches a little below.

Besides several branches which go from its upper part to the lower part of the anterior muscles of the neck, it sometimes gives off a superior bronchial artery, the thymic, and a branch which is distributed to the pericardium, and also to the anterior mediastinum. But its upper part constantly gives off a branch which accompanies the diaphragmatic nerve, called the *superior diaphragmatic* artery (*A. diaphragmatica superior*, s. *pericardio-diaphragmatica*). This branch sends ramuscules to the pericardium, to the internal wall of the mediastinum, and to the esophagus, and expands in the anterior and middle portion of the diaphragm, where it anastomoses with the inferior diaphragmatic artery.

In its course along the sternum the internal mammary artery gives off external and internal branches.

The external branches, the *anterior intercostal* arteries, (*A. intercostales anteriores*), are usually larger and more numerous than the internal. Their number is not exactly the same in every part, but they equal in number the intercostal spaces, over which the internal mammary artery passes. They generally proceed along the lower, rarely along the upper edge of the ribs, and almost always in the latter case one intercostal space contains two of them. They go backward between the intercostales interni and externi muscles, and anastomose with the intercostal arteries given off by the descending aorta and with the thoracic arteries which arise from the axillary artery.

One of these branches, the fifth, sixth, or seventh, has been called the *musculo-diaphragmatic* artery (*A. musculo-phrenica*). It is usually very considerable, sometimes as large as the trunk, of which it seems even to be a continuation. It is distributed not only to the anterior part of the diaphragm, but it also arrives at the upper part of the broad abdominal muscles, whence its name, where it anastomoses with the epigastric artery.

The internal branches, which are smaller and fewer than the preceding, go, some to the internal face of the sternum, others to the anterior face of the pericardium, and some, viz. the deepest, to the anterior part of the diaphragm; finally, others leave the pectoral cavity through the intercostal spaces and are distributed in the upper part of the abdominal muscles.

The trunk of the internal mammary artery commonly divides into two principal branches of different sizes, an external and an internal. This bifurcation occurs sometimes higher and sometimes lower, and occasionally it is seen opposite the anterior extremity of the fifth rib, and sometimes only opposite the eighth.

The external branch goes obliquely outward, along the costal cartilages, above the intercostal spaces. It terminates by the lowest of the

anterior intercostal arteries and by small branches which enter the anterior edge of the diaphragm and the upper part of the broad abdominal muscles. It is also called the *superior epigastric* artery (*A, epigastrica superior*).

The internal branch proceeds perpendicularly downward, passes between the anterior and internal digitations of the diaphragm, and comes upon the posterior wall of the rectus abdominis muscle, where it soon divides into several branches, which descend vertically and anastomose as high as the umbilicus with the ascending branches of the epigastric artery and also with the ramifications of the external branch.

II. SUPERIOR INTERCOSTAL ARTERY.

§ 1399. The *superior intercostal* artery (*A. intercostalis suprema*, s. *prima*) arises more externally than the preceding, and is given off from the posterior part of the subclavian artery. It is the smallest and the most external of the four constant branches of the latter, and varies in size. Sometimes it is very small; in this case it arises almost always directly from the subclavian artery. It is rarely given off by the inferior thyroid artery, and it frequently arises by a common trunk with the deep cervical artery.

The distribution of this artery varies very frequently, especially in regard to its extent. It however always goes downward and outward, passing on the neck, and gives upward and downward branches, of which the lower are much larger than the upper.

The superior branches go to the transversalis colli muscle and send branches to the deep muscles of the back.

The inferior, which are a continuation of the trunk, divide into external and internal or posterior branches.

The *external* or *intercostal* branches (*R. interossei*) proceed along the lower edge of the first and second ribs, between the intercostales interni and externi muscles. They generally do not extend very far forward and divide into two ramuscules, an upper and a lower, which follow, the former the lower edge of the upper rib, and the second the upper edge of the lower rib, and are distributed in the posterior part of the intercostales muscles between which they proceed, and anastomose before with the superior anterior intercostal arteries (§ 1397). Sometimes we find two branches in the same intercostal space, one of which gives off two twigs.

The *posterior*, *internal*, or *dorsal* branches (*R. dorsales*) usually arise more or less opposite the external and divide like them into two ramuscules, the internal of which is almost always larger than the other, and enters into the spinal canal through the intervertebral foramen, is distributed to the spinal membranes and the spinal marrow, and anastomoses with the spinal arteries which arise from the vertebral artery; while the external, proceeding between the ribs goes backward, where

it enters the deep muscles of the back, the multifidus spinæ and the spinalis dorsi.

When the superior intercostal artery is very small, it is distributed only to the first intercostal space, but its branches generally extend to the second.

It more rarely gives origin, as we have already said, to the deep cervical artery, and it also gives off very near its origin an *esophageal* or *bronchial* artery (*A. œsophagea et bronchialis*), which varies in size and turns inward and forward, sending branches to the lower part of the trachea, also to the centre of the esophagus, and likewise gives them to the bodies of the upper dorsal vertebræ, and communicates by broad anastomosing branches with the other esophageal and bronchial arteries.

§ 1400. The subclavian artery gives off those branches only which we have described. Sometimes however it sends from its lower and anterior side a considerable branch to the lymphatic glands in the upper region of the chest. It also gives off above the lower extremity of the scalenus anticus others, which go outward to some of the axillary glands.

§ 1401. The artery of the upper extremity then assumes a transverse direction, separates from the trunk, goes downward and outward between the scalenus medius and anticus, and is called the axillary artery.

II. AXILLARY ARTERY.

§ 1402. The *axillary* artery (*A. axillaris*) extends from the scaleni muscles to the lower extremity of the axilla. It is situated between the chest and the arm, its upper part being nearer the former, while its lower part approaches the latter, because it proceeds obliquely downward and outward. For a short space its upper part is covered only by the skin and the platysma myoides muscle; below we find the clavicle before it, as it passes behind its centre the subclavius muscle, and still lower the outer part of the pectorales muscles. Backward and outward we observe, above, the brachial plexus, then the subscapularis muscle, the scapulo-humeral articulation, and the tendon of the latissimus dorsi muscle. On its inside it has, above, the first two ribs, below, the serratus magnus muscle.

It is imbedded in a very loose cellular tissue, and is surrounded by the axillary glands, and is attached but feebly to the adjacent parts, excepting a small portion of its upper part. As in this place it rests on the first and second ribs, it may easily be compressed whenever an operation near or within the scapulo-humeral articulation requires it.

§ 1403. Several branches, which are not very constant, arise from this artery. The principal, regarded from above downward, are the external thoracic arteries, the inferior scapular artery, and the circumflex arteries. These branches vary in respect to volume, number, and origin, because sometimes many of them arise by a common trunk, and

again sometimes one or more come much lower than usual from the brachial artery, or finally in some cases by a trunk in common with the deep brachial artery.

Besides these branches the axillary artery also gives off, in part or entirely, far outward above, one or more of the external thoracic arteries, the transverse scapular artery, so that the principal portion of this latter artery arises at its usual place, but its smallest branch distributes itself to the subscapularis muscle. This anomaly is very remarkable, because it gradually leads to another, which is much greater, where the transverse scapular artery is entirely deficient, or at least is very small; so that the branches usually given to the muscles of the scapula come from the superficial scapular artery.

I. EXTERNAL THORACIC ARTERIES.

§ 1404. The *external thoracic* arteries (*A. thoracicæ externæ*, s. *alares*) vary in number from three to six.

Some arise from the inside, others from the outside of the axillary artery.

§ 1405. The former are usually smaller than the latter. They go principally to the superior external intercostal muscles, to the pectoralis minor muscle, to the axillary and thoracic glands, and go downward and forward even to the skin. Sometimes we find only one, and again there are two, which are then much smaller. One of these two arteries, and when there is only one, that one usually arises highest from the trunk of the axillary artery; it is then termed the *superior external thoracic* artery (*A. thoracica externa suprema*, s. *prima*), and is also called the *small external thoracic* artery (*A. thoracica externa minor*), because it is always smaller than the others.

§ 1406. The second external thoracic artery is rather constant and is called the *acromial* artery (*A. acromialis*). It arises from the outside of the axillary artery and is sometimes single and sometimes double. In the latter case, some of the branches usually given off by the single trunk generally arise very near each other, from the axillary artery.

This artery gives off, first, upward and forward and upward and outward, small branches which go to the subclavius muscle; second, others below, which go to the inner part of the upper edge of the deltoides muscle and also to the upper part of the capsular ligament of the shoulder, where they anastomose below the acromion process with the branches of the superior scapular artery.

Larger and more numerous branches arise forward, inward, and downward, above and below the pectoralis minor muscle; they enter this muscle and also the pectoralis major muscle from within and without, and are distributed principally in them.

Others, which pass on the pectoralis minor muscle, go outward and forward toward the anterior and internal edge of the deltoides muscle, into which they penetrate from below upward, and extend to the capsular ligament of the scapulo-humeral articulation, on the surface of

which they anastomose with the preceding and also with the branches of the inferior scapular artery and the anterior circumflex artery. They penetrate also to the posterior muscles of the scapula and to the subscapularis muscle.

A constant branch descends along the inner edge of the deltoides muscle, between it and the pectoralis major muscle, at the side of the cephalic vein. This branch is always considerably large, and it arises sometimes directly from the axillary artery, but then it comes below all the others from which it is very remote, and no longer proceeds between the deltoides and the pectoralis major muscles, but descends below the latter, between the coraco-brachialis and the two heads of the biceps flexor muscle, and gives off considerable branches to these two muscles.

Other branches, which are still lower, go to the axillary glands, to the serratus magnus, and sometimes to the trapezius muscle.

§ 1407. The third, or, when the first or the second or both are double, the fourth or the fifth *external thoracic* artery, the *long thoracic*, or the *external mammary* artery (*A. thoracica externa longa, mammaria externa*) is given off so constantly by the subscapular artery that it should never be described as a separate artery. We shall mention it hereafter.

§ 1408. Not unfrequently two branches, which arise from the subscapular artery, come directly from the axillary artery and form a third, fourth, or fifth external thoracic artery, which is distributed to the subscapularis muscle.

II. SUBSCAPULAR ARTERY.

§ 1409. The *subscapular* artery, the *inferior* or *common scapular* artery (*A. subscapularis, scapularis inferior, infra-scapularis, scapularis communis*) is generally the largest branch of the axillary artery and sometimes equals this trunk in size. It arises near its inferior extremity, at the lower edge of the tendon of the subscapularis muscle; so that its origin is covered by the brachial plexus. It is rarely given off lower down.

Its origin is very constant, and when it arises from the inferior thyroid artery it is one of the rarest anomalies, and occurs certainly only in regard to its upper part.

The volume and number of its branches vary. In its greatest development it gives off, first, the final external thoracic arteries, which we have already described, which are its first branches, and which go upward and backward and are distributed in the infraspinatus muscle; 2nd, and 3rd, one or two circumflex arteries of the arm; 4th, even the deep brachial artery in whole or in part; 5th, the long external lateral thoracic artery (§ 1407), more rarely the second, third, and the fourth branches, usually the first and the fifth.

After giving off the first subscapular branches, the artery proceeds upward and downward and divides into two branches, an inferior descending branch and a superior, which is larger, goes backward and is

the continuation of the trunk, and is called the *circumflex* artery of the scapula (*A. circumflexa scapulæ*).

The circumflex artery of the scapula, shortly after giving off the ascending branch, sends off several beside, some of which are large and others small, to the outer edge of the subscapularis muscle, to the teres minor and major muscles, to the axillary glands, the skin of the axilla and of the back, and to the subscapularis muscle. It afterwards curves around the neck f the scapula, passes on its posterior face, where it is called the *dorsal* artery of the scapula (*A. dorsalis scapulæ*), when it is very much developed, penetrates partly into the bone, and ascends partly also upward and inward into the subscapularis muscle, advances on the neck of the scapula, and anastomoses with the acromial and with the superior scapular arteries; finally, when the latter is smaller or deficient, it re-ascends below the spine of the scapula into the supraspinalis fossa, and distributes branches to the supraspinatus and likewise to the trapezius muscle.

When it is less developed it does not penetrate deeply between the scapula and the infraspinatus muscle, but only into the posterior part of the deltoides muscle, and anastomoses with the preceding arteries on the acromion process and on the anterior edge and even in the substance of the infraspinatus muscle.

The descending branch goes inward, backward, and downward, along the external wall of the chest, in the broad muscles of the back, the lower part of the serratus magnus muscle, the intercostales muscles, the thoracic glands, the lower part of the subscapularis muscle, and several of the axillary ganglions.

The portion of this branch which is distributed in the serratus magnus muscle is the *long external thoracic* artery, which very rarely arises from the trunk of the axillary artery.

III. CIRCUMFLEX ARTERIES OF THE ARM.

§ 1410. There are two *circumflex* arteries of the arm (*A. circumflexæ*, s. *articulares humeri*), an *anterior* and a *posterior*.

a. Anterior circumflex artery of the arm.

§ 1411. The *anterior circumflex* artery of the arm (*A. circumflexa anterior humeri*, s. *articularis anterior*) often arises a little higher than the posterior, sometimes also much higher, in some cases at the same height, and sometimes still lower.

It is always much smaller than the latter, but it rarely arises from it or from the subscapular artery.* It comes very constantly from the outer and anterior side of the axillary artery, a little above the upper

* We have never seen it arise from the deep brachial artery, of which Mayer (p. 123) asserts it is sometimes a branch.

edge of the tendon of the latissimus dorsi muscle. It goes outward on the anterior part of this tendon, directly on the humerus, below the common tendon of the biceps flexor and of the coraco-brachialis muscles, to which it gives ramuscules, and also to the periosteum, and divides into upper and lower branches. The latter are fewer and smaller than the former; they turn inward, some go partly to the internal portion of the deltoides muscle, where they anastomose with the posterior circumflex artery, while the others pass downward on the tendon of the latissimus dorsi muscle, to which they give branches, and anastomose with the recurrent branches of the superficial brachial artery.

The upper branches are larger and more numerous, and proceed directly on the humerus; they ascend toward the upper part of the humerus and give ramifications to this bone, expand in the scapulo-humeral articulation, penetrate to the supraspinatus and the infraspinatus muscles, and anastomose with all the arteries of the shoulder which arise from the subclavian and the axillary arteries.

Sometimes another analogous artery exists, which distributes its branches principally to the latissimus dorsi, to the upper part of the biceps flexor, and to the brachialis internus muscles. This artery is frequently only a branch of the anterior circumflex artery.

b. Posterior circumflex artery of the arm.

§ 1412. The *posterior circumflex* artery of the arm (*A. circumflexa humeri posterior*) is always much larger than the preceding. It arises from the subscapular or from the deep brachial artery by a common trunk, which varies in length but is never very long, more frequently than from the axillary artery. It very rarely forms a common trunk with the anterior circumflex artery, and when this anomally occurs, the subscapular artery also arises from this trunk, In the former case it arises no higher, or at most not much higher, than when it comes directly from the axillary artery. But when it comes from the axillary artery it is lower than usual by the length of the whole tendon of the latissimus dorsi muscle, sometimes by about two inches; for in all the cases at least where we have observed this arrangement (which, so far from being rare, is perhaps the most common), the deep brachial artery arose as usual. The posterior circumflex artery is then reflected from below upward, behind the tendon of the latissimus dorsi muscle, and ascends between the two heads of the biceps flexor muscle until it comes a little above the upper edge of this tendon, that is, until it rises as high as its normal origin. It then goes backward to turn on the humerus. We have sometimes seen the deep brachial artery arise very high and near the posterior circumflex artery; but we have never found that it then came from the same trunk as the latter, which has led us to think that when these two vessels arise from a common trunk we must not consider the deep brachial artery as a branch of the pos-

terior circumflex artery, as Murray* and Sœmmerring† have done, but we must regard the posterior circumflex artery as a branch of the deep brachial.‡

The posterior circumflex artery is reflected outward and forward on the neck of the humerus, between this bone and the long head of the triceps extensor muscle. Proceeding onward, it distributes branches to this long head, to the capsular ligament of the scapulo-humeral articulation, to the teres minor and to the outer head of the triceps muscle. After giving off these branches, which are proportionally very small, it proceeds inward on the inner face of the deltoides muscle, in which it is entirely lost, and of which it is the principal artery. It anastomoses behind and above it with the anterior circumflex, the subscapular, and the superior scapular arteries.

The axillary artery sometimes gives off, above or below these two arteries, some small branches, which enter the biceps flexor, the long head of the triceps, the teres major, and the latissimus dorsi muscles.

III. BRACHIAL ARTERY.

§ 1413. When the artery of the upper extremity leaves the axilla at the upper edge of the tendon of the latissimus dorsi muscle, it is called the *brachial humeral* artery (*A. brachialis*, s. *humeraria*). It goes between the insertions of the teres major and latissimus dorsi muscles and the coraco-brachialis, which it covers, to the inside of the biceps flexor muscle and to the inner face of the arm; so that it crosses the direction of the humerus and becomes more superficial the farther it descends, since toward its lower extremity it is covered only by the brachial aponeurosis and the median vein and the skin. Its upper part rests directly on the humerus, and the lower on the brachialis internus muscle. It usually extends to the anterior face of the humero-cubital articulation, near which it terminates in most subjects. It not unfrequently however terminates higher, and sometimes does not exist at all, and then the branches usually given off in the elbow arise in the axilla.

The largest and uppermost branches go inward; they form the deep brachial artery or arteries. The origin of this artery, especially when it gives off branches which usually come from the axillary artery, as particularly the posterior circumflex artery of the arm or the subscapular artery, may often be considered as a point where the brachial artery divides into two branches, a superficial, which is the continuation of the trunk, and a deep branch.

§ 1414. The *deep brachial* or *external collateral* artery, *Grand musculaire du bras*, Ch. (*A. profunda humeri*, s. *brachii*, s. *collateralis*

* *Descript. art. in tab. redacta*, p. 41.

† Sœmmerring, *Gefässlehre*, p. 206.

‡ This remark has not escaped Mayer, who says (*loc. cit.*, p. 123) that one or even both the circumflex arteries arise from the deep brachial artery in rare cases.

magna, s. *superior*), usually arises below the lower edge of the latissimus dorsi muscle, above the small head of the triceps extensor muscle. It accompanies the radial nerve, which it almost always covers, penetrates between the three heads of the triceps muscle, to which it gives branches, turns from within outward upon the humerus, so that its lower extremity is situated on the outside of this bone, and commonly terminates at the articulation of the elbow, where it is distributed to the supinator longus and the extensor carpi radialis muscles. It also sends branches to the brachialis internus and to the anconeus muscle, supplies the nutritious artery of the humerus near the centre of its course, and having come to the outside of the elbow, it penetrates into the anconeus muscle, where, termed the *collateral radial* artery (*A. collateralis*, s. *communicans radialis a profunda*), it anastomoses with the recurrent branch of the ulnar artery. One of these branches, which sometimes arises from the brachial artery, always lower than it but directly under it and sometimes a little distance from it, and which is always smaller, goes farther forward, descends between the long and short portions of the triceps to which it gives branches, anastomoses with the inferior lateral branch of the brachial, and communicates, under the name of the *collateral ulnar* artery (*A. collateralis ulnaris*, s. *communicans ulnaris a profunda*), with the recurrent branch of the interosseous and ulnar arteries, on the inner and posterior face of the humero-cubital articulation.

Thus the deep brachial artery is distributed principally to the extensor muscles of the fore-arm. It anastomoses above with the subclavian and below with the trunk of the brachial artery and with the arteries of the fore-arm.

§ 1415. Below or above the deep brachial artery, when it is single, or even between it and the collateral ulnar artery, when the latter forms a distinct trunk, we usually see arise a branch, which goes to the longer portion of the triceps muscle and which anastomoses with the posterior circumflex artery of the arm. This branch sometimes arises from the deep brachial artery. The brachial artery then gives off, forward, outward, and backward, at right angles, about twelve very short differently sized branches, which penetrate into the biceps and the brachialis internus muscle. Some of them go only to one of these muscles, but most of them are common to both. One of the largest, which arises from the posterior and internal part of the brachial artery, about two inches above the elbow, is called the *large anastomotic* or *internal collateral* branch, or more properly the *inferior anastomotic* branch, or the *inferior deep brachial* artery (*R. anastomoticus magnus inferior*, s. *A. profunda inferior*) ; the first of these terms is applied to it because it establishes a communication between the trunk of the brachial artery and the arteries of the fore-arm. It proceeds inward, passing on the brachialis internus muscle, to which it gives ramuscules, as also to the pronator teres, unites first by a transverse branch with the ulnar branch of the deep brachial artery, which connects it with the recurrent branch

of the ulnar artery; then anastomoses on the posterior face of the articulation of the elbow with the radial branch of the deep brachial artery, and thus forms the *dorsal arch of the elbow* (*arcus dorsalis articularis cubitalis*), and communicates in this manner with all the anastomosing branches of the fore-arm.

This branch sometimes comes from the radial artery when the latter arises much higher than usual, but its origin is not constant, and then it is sometimes supplied by the continuation of the trunk of the brachial artery—an arrangement which Bichat* erroneously considers as a general law in such cases. This branch comes from the ulnar artery much less frequently when the latter is given off much higher than usual. It rarely sends off from its outside, above the articulation of the elbow and directly above where the brachial artery bifurcates to give rise to the two arteries of the fore-arm, a considerable branch, which ordinarily comes from the radial artery, and which is called the *recurrent radial* artery (*A. radialis recurrens*).†

The two large anastomoses which we have described permit the application of a ligature upon all parts of the brachial artery, without causing any derangement in the circulation and nutrition of the fore-arm.

IV. ARTERIES OF THE FORE-ARM.

§ 1416. The brachial artery usually divides a little below the elbow where the tendon of the biceps penetrates between the muscles of the fore-arm, into two branches, the *radial* and the *ulnar* artery. This bifurcation rarely and perhaps never takes place much lower, while it not unfrequently occurs higher than usual. Of the two trunks of the fore-arm, the radial is the continuation of the brachial artery as respects its direction, but in most cases it is smaller than the ulnar artery, at whatever height the brachial artery divides. It is nearer the surface than the latter and arrives at the lower extremity without giving off any considerable branches except one, which arises from its upper part. The ulnar artery, on the contrary, soon divides into two branches, one of which is the proper continuation of the trunk, and the other the interosseous artery.

I. ANOMALIES IN THE ORIGIN OF THE ARTERIES OF THE FORE-ARM.

§ 1417. The brachial artery not unfrequently divides unusually high (§ 1416) ‡. This anomaly varies in its *mode* and *degree*. The principal laws in both these respects are as follow:

* *Anat. descrip.*, vol. iv. p. 230.

† This arrangement is very rare. We have seen it but once only, and we cannot find it mentioned by any writer. It does not affect the anastomoses around the elbow joint, because in this instance the recurrent radial artery did not arise much higher than usual.

‡ See our *Mémoire sur les differentes variétés qu'on observe dans la distribution de l'artère brachiale*; in the *Journ. compl. du dict. des sc. méd.*, vol. iii. p. 31.—

a. In regard to *mode*, we observe three principal differences. In fact, the artery which arises unusually high is sometimes the radial, sometimes the ulnar, and finally sometimes the interosseous artery. Observation confirms what might be admitted on conjecture, that the first of these three anomalies is the most common and the last the rarest; which evidently depends on the fact, that in producing the first, nature conformed to the primitive type in this respect, that the artery which is generally given off first, that is the radial artery, generally arises higher than usual. In the second anomaly, although the division takes place higher than usual, there is also an inversion, since the interosseous artery comes from the radial artery and the ulnar artery arises above the latter. Finally, in the third the anomaly is still greater, since a vessel usually given off by a branch of the brachial artery, the ulnar artery, arises directly from the trunk.

The ulnar and radial arteries are distinguished from each other when they arise higher than usual, because the former is commonly more superficial than the latter, and it then is frequently situated between the aponeurosis and the skin, an arrangement which, judging from our observations, is not always constant.

But in whatever manner this abnormal division of the brachial artery above its usual point occurs, the vessel which it thus prematurely produces is always situated in the arm, directly at the side of the superficial brachial artery.

b. In regard to the *degree*, we may consider the anomaly either in itself or in relation to the whole vascular system.

First, considered in regard to itself, it presents several differences, of which the principal are as follow;

1st. The first degree consists in the existence of *abnormal vessels* (*vasa aberrantia*), greater or less branches, which arise from the upper part of the superficial brachial artery, and empty into its lower part, or, as is more common, into an artery of the fore-arm, particularly the radial artery. In this case both the normal and the abnormal division exist, and the artery of the fore-arm into which the abnormal vessel empties, arises in fact by an upper and a lower root. The normal type gradually passes to the abnormal formation by the increase of the first of these roots and the diminution of the second, until the latter type is perfect, when the lower root entirely disappears.

2nd. A second degree is when the brachial artery divides more or less above its usual place. This division occurs in fact, in all parts between the axilla and the humero-cubital articulation. The three arteries of the fore-arm differ from each other in this respect, that although the radial artery arises unusually high much more frequently than the ulnar artery, still when the anomaly exists, the ulnar artery comes from a higher point, particularly from the axillary artery itself, while the

: have there given our own observations and the principal of those collected other authors.

radial artery is given off near the middle of the arm. When the interosseous artery is abnormal in this respect, it arises either from the angle of the bifurcation as usual or from a higher point.

Second, considered in regard to the whole vascular system, this anomaly exists on one side only or on both sides at once. Bichat asserts that he has seen the first case oftener than the second, but our own observations and those of other anatomists prove the contrary.

This anomaly however is by no means the same on both sides in regard to the manner and the degree, and we more commonly observe differences in one or the other of these two relations than the contrary, or a perfect similitude between the two sides of the body. We cannot yet say if the anomaly is observed on the left side more frequently than on the right when it is seen only on one side, and if it is more distinct on this side than on the other when it occurs on both sides, although this seems very probable, reasoning from the differences between the formative types of the two sides, and also from other anomalies, and from the observations which we have been able to collect.

All these anomalies are equally important in a physiological or surgical point of view. They concern physiology, because they imitate the two superficial veins of the arm. The surgeon ought always to observe them carefully, because they increase the chance of injury to the arteries of the arm, and because, when the course of the blood in the brachial artery is in any manner interrupted, it re-establishes the circulation in the upper extremity more easily.

II. RADIAL ARTERY.

§ 1418. The *radial* artery (*A. radialis*) is usually much smaller and nearer the surface than the ulnar artery; but in considering its direction only, it is a continuation of the trunk of the brachial artery. It is much smaller when the recurrent radial artery arises from the brachial artery. Less frequently still it is larger, which occurs when the interosseous artery arises from it instead of coming from the ulnar artery as usual.

This artery descends a little obliquely from behind forward, along the radius to the radio-carpal articulation, where it glides under the tendons of the extensor digitorum communis muscle, and penetrating into the palm of the hand, between the first and second metacarpal bones, it anastomoses with the ulnar artery.

§ 1419. The first branch of the radial artery is generally the *recurrent radial* artery (*A. recurrens radialis*), when the latter does not come from the brachial artery, which rarely happens. It arises as rarely from the ulnar artery, which we have observed only a few times, when the radial artery arose much higher than usual; even then the recurrent radial artery can be considered only as divided into two portions, for the radial artery gives off a muscular branch, which is detached higher than usual. In the most frequent cases, in fact, the brachial artery divides into three trunks and gives off the recurrent

ranch at the place with the two others; but this artery constantly rises very high from the radial artery, which even in the adult passes hrough but a very few lines before it is sent off. It is always the rgest branch which this artery gives to the fore-arm; so that we ay say that the radial artery, as soon as it arises, divides into two ranches, one of which continues to proceed in the direction of the unk and is the proper radial artery, and the other is smaller and is e recurrent artery. The latter gives branches to the pronator teres, e supinator longus, the supinator brevis, and the extensor carpi ra- alis muscles, to the capsular ligament, to the inner portion of the iceps extensor, and is reflected from below upward, between the su- nator longus and the extensor carpi radialis longus, to anastomose th the recurrent radial artery given off by the deep brachial artery the inner tuberosity of the humerus.

At the same place, sometimes a little higher, the radial artery gives a small recurrent branch, which goes into the lower part of the ier portion of the brachialis internus muscle. It then gives off from outer and inner sides, and at right or nearly right angles, and very r each other, small branches, almost uniform in size, and at least ty in number. Of these, the internal are distributed to the prona- teres, the flexor carpi radialis, the flexor digitorum sublimis, the or pollicis longus, the pronator quadratus muscle, and the capsule he radio-carpal articulation; while the external are distributed in pronator teres, the pronator quadratus, and the extensor carpi ra- lis.

1420. Toward the lower end of the radius, the radial artery con- tly gives off a branch, which passes on the radial edge of the car- , enters into the palm of the hand, and is called the *superficial pal-* artery (*A. superficialis volæ*). This branch is always situated below palmar aponeurosis, and proceeds toward the ulnar edge of the d to meet the ulnar artery. This branch is sometimes and not ly so large, that we have reason to say that the radial artery bifur- s in the place where it arises to produce it and also the continua- of the trunk which goes on the back of the hand. When this ch is small, it is frequently but not always distributed only to the ll muscles of the thumb. When it is considerable, it usually but always anastomoses with the ulnar artery to form the *superficial ar arch* (*arcus volaris superficialis*), and contributes as much as atter to produce it.

metimes the superficial palmar artery arises much higher than l and proceeds in the same direction as the radial artery, with h however it cannot be confounded, as it is more superficial and fixed in its situation.

is essential to remember this circumstance, in order not to be in when we wish to ascertain the state of the pulse by feeling the l artery.

1421. When the superficial palmar artery concurs to form a su- cial palmar arch, it gives off very distinctly some *digital palmar*

arteries (*A. digitales volares*). In two preparations now before us i gives off the *digital palmar artery of the thumb* (*A. digitalis volaris u naris pollicis*) and the *digital palmar artery of the index finger* (*A. d gitalis volaris radialis indicis*).

Usually, when the superficial palmar artery is not very small, th superficial palmar arch is double, because, beside the large anasto mosing anterior twig of this branch, we find another, which is smalle and more transverse and posterior.

However small the superficial palmar artery may be, and even whe it does not contribute to form the superficial palmar arch, it howevc is never entirely deficient, and always anastomoses with the continua tion of the trunk of the radial artery at the bottom of the palm of th hand. We have never seen it arise except under the pronator quadra tus, or at least toward its posterior edge, and constantly below th place where the radial artery rests almost directly on the radius. W must except some but not all those cases, where the radial artery arise from the brachial artery extremely high, and imitating the type of th latter, bifurcates unusually high, for instance near the elbow.

§ 1422. After giving off the superficial palmar artery, the continu tion of the trunk of the radial artery goes usually on the back of th hand, passing between the styloid process of the radius and the os tra pezium; but sometimes it is reflected higher on the outer face of th radius and of the fore-arm, and produces the following branches:

1st. Branches which go to the ligaments of the carpus and also the flexor brevis pollicis and the abductor pollicis proprius.

2nd. The *dorsal artery of the thumb* (*A. dorsalis pollicis*), whi arises from its outside, extends along the radial edge of the metaca pal bone of the thumb and of all the phalanges of this finger, anast moses with its digital palmar artery, and rarely arises from the s perficial palmar artery given off by the radial artery.

3rd. The *dorsal artery of the carpus* (*A. dorsalis carpi radiali* arises from the inside of the radial artery, more or less opposite t preceding, goes transversely toward the ulnar edge of the hand, a passing under the tendons of the extensor muscles, directly on t dorsal ligaments of the carpus, anastomoses with small branches the radial artery which were given off higher than the latter, th with the extremity of the interosseous artery, finally with the dor branch of the ulnar artery, and thus forms the *dorsal arch of the c pus* (*arcus dorsalis carpi*), which resembles an arch less than a ne work with large meshes.

§ 1423. The *dorsal interosseous* arteries (*A. dorsales interosseæ*) ar principally from this arch. They proceed from behind forward in t spaces between the metacarpal bones from the second finger to t fifth, go to the external interosseous muscles, and are continuo first forward, with the corresponding digital arteries between the p terior extremities of the first phalanges, in the place where the tru of these arteries bifurcates; second, with the inferior metacarpal

eries, whence results a large circle of anastomoses between the dor-al and the palmar branches of the arteries of the fore-arm.

§ 1424. Next come smaller ramifications, which enter the abductor adicis proprius muscle and the ligaments of the carpus; then, between he posterior extremities of the first two metacarpal bones, arise the *orsal cubital artery of the thumb* (*A. dorsalis ulnaris pollicis*) and the *orsal radial artery of the index finger* (*A. dorsalis radialis indicis*), hich arise sometimes separately and sometimes by a separate trunk.

§ 1425. When the radial artery has given off these branches, it nters into the palm of the hand between the first two metacarpal ones and the adductor indicis muscle, goes transversely toward the lnar edge, and anastomoses with the ulnar artery, which meets it so s to form a *deep palmar arch* (*arcus volaris profundus*), and contributes o produce it more than the latter. When passing on the posterior xtremity of the metacarpal bone of the index finger, it gives rise to ie *large artery of the thumb* (*A. princeps*, s. *magna pollicis*). The latter vides sometimes into the *palmar radial* and the *palmar ulnar artery f the thumb* (*A. volaris pollicis radialis et ulnaris*), sometimes furnishes ly one of these two branches, while the other arises near the super-ial or from the deep palmar arch; but it always anastomoses by one two large branches with the radial and the ulnar dorsal arteries of e thumb, even when the corresponding palmar arteries do not arise om it.

The radial artery rarely divides when passing through the first in-rosseous space, into two branches, one of which is the continuation the trunk and goes into the palm of the hand, while the other is naller, passes over the internal belly of the first external interosse-s muscle, and anastomoses with the superficial palmer arch, giving igin to the *palmar cubital artery of the thumb* (*A. volaris ulnaris pol-is*), where it divides into this artery and the *palmar radial artery of e index finger* (*A. volaris radialis indicis*), which formation is remark-le because it strengthens the resemblance with the arteries of the her fingers, as this dorsal branch then represents the first dorsal etacarpal artery, which is the largest. Sometimes but very rarely ese arteries do not arise from the large artery of the thumb, but from e superficial palmar arch and directly from the superficial palmar ra-l artery. In this case the palmar and the large arteries of the thumb, hich are proportionally smaller, give off only the dorsal arteries of the umb. Nevertheless, we have never seen this arrangement except hen the radial and the palmar radial arteries arose unusually high.

Even at the place where the large artery of the thumb arises, and ly little more on the anterior side of the radial artery, a very constant anch arises, which however varies in size; this goes inward and sses directly on the palmar face of the second metacarpal bone, gives anches to the adductor pollicis muscle, and contributes more or less form the palmar arteries of the index finger. This however is not ways the case; so that the radial artery of this finger always comes

from the branch of which we were speaking, as Sœmmerring pretends; for we have sometimes seen, notwithstanding the considerable size of the latter, the radial artery of the index finger coming from the superficial palmar arch. We may then, in order to express the analogy between it and the large artery of the thumb, term this branch the *large artery of the index finger* (*A. princeps indicis*).

We shall describe the deep palmar arch when speaking of the ulnar artery.

III. ULNAR ARTERY

§ 1426. The *ulnar* artery (*A. ulnaris*, s. *cubitalis*) is generally the largest of the two branches produced by the bifurcation of the brachial artery; it goes toward the ulna sooner after arising, passes below the pronator teres, and proceeds toward the hand, along the ulna, between the flexor ulnaris and the flexor digitorum profundus muscles, and is always situated deeper than the radial artery. It gives off near its origin a small or large branch, the *anterior recurrent ulnar* artery, which penetrates to the lower extremity of the inner portion of the triceps extensor and also into the upper extremity of the pronator teres, and corresponds to a similar branch given off by the radial artery.

§ 1427. It then sends off the *recurrent* or the *posterior recurrent ulnar* artery (*A. recurrens ulnaris*, s. *cubitalis*), which is generally much larger than the preceding, and proceeds from below upward between the flexores digitorum sublimis and profundus and the flexor ulnaris, distributes branches to these muscles, penetrates through the latter, and ascends between the inner condyle of the humerus and the olecranon process, and unites with the inferior and internal collateral artery which comes from the brachial artery, and thus forms the largest anastomosis which exists around the humero-cubital articulation. This artery always arises much lower than the recurrent branch of the radial artery. It comes very constantly from the ulnar artery, when the latter arises as usual from the brachial artery; at least we have never seen it arise directly from the humeral artery, as does the recurrent radial artery, which undoubtedly must be attributed to its arising so slow. On the contrary, in all those cases where the ulnar artery ascended unusually high, the recurrent artery was not given off by it but by the interosseous artery; so that then even the anomaly approached as near as possible the normal formation.

§ 1428. Soon after giving off this branch, the ulnar artery divides into two others, the *proper ulnar* artery and the *interosseous* artery (*A. interossea*), which is usually smaller than the other. The latter is rarely given off by the brachial artery, either at the usual place of its bifurcation* or above this point.† When the ulnar artery arises

* Barclay, *Description of the arteries of the human body*; in the *Edinb. Med. and Surg. Journ.*, vol. viii. p. 468.

† Monro, *Outlines of Anatomy*, vol. iii., p. 304.

unusually high, the interosseous artery is a branch of the radial artery, whence it arises in the same region of the fore-arm, although it comes from a different artery.

From these two causes the ulnar artery is much smaller than usual when it arises uncommonly high. This diminution of calibre is sometimes observed in it, although its origin is not abnormal, because the interosseous artery, although very rarely, arises from the radial.

The interosseous artery gives off near its origin one or two very constant branches, which descend into the upper part of the flexores digitorum sublimis and profundus, into the flexores carpi radialis longus and brevis muscles, and the pronator teres. Lower down it divides into two branches, nearly equal in size, one of which is a little larger, and is a continuation of the trunk, and descends on the anterior face of the interosseous ligament, while the other passes above the upper edge of this ligament to go to the dorsal face of the fore-arm. This branch is the *superior perforating* artery (*A. perforans prima suprema*), which soon divides into two branches. The smaller, which is however considerable, is called the *recurrent interosseous* artery (*A. recurrens interossea*), re-ascends above the extensor carpi ulnaris muscle, between the radius and the ulna on one side and the anconeus muscle on the other, and empties into the dorsal arch of the articulation of the elbow. The larger descends between the origin of the extensor longus and the abductor pollicis longus on the one side, the extensor digitorum and the extensor carpi ulnaris on the other, along the ulna to its lower extremity, and in its course gives off numerous branches to the muscles which we have mentioned.

§ 1429. The trunk of the interosseous artery descends in most of its extent on the anterior face of the interosseous ligament, between the two bones of the fore-arm, a little nearer the ulna than the radius, gives small twigs to all the flexor muscles, and also supplies six or seven branches, the *inferior perforating* arteries (*A. perforantes minores inferiores*), which pass through the interosseous ligament, glide on the posterior face of the fore-arm, and are distributed in the extensor muscles. The arterial trunk terminates in passing above the upper edge of the pronator quadratus to the dorsal face of the fore-arm, where it divides into three or four branches, nearly equal in size. One or two of these branches are distributed partly in the extensor and the abductor pollicis, and partly also pass under the tendons of these muscles, resting directly on the bone, turn on the radius, and anastomose with the branches of the radial artery. The second or the third, which retrogrades on the ulna, anastomoses with the superior perforating artery. The third or the fourth, which is the continuation of the trunk, descends between the two bones of the fore-arm and forms the *dorsal arch of the carpus* (*arcus dorsalis carpi*) on the back of the carpus, and divides into a middle and at least two lateral ramusculos, which communicate with the carpal branches of the radial and ulnar arteries.

§ 1430. The trunk of the interosseous artery rarely gives off a long branch, which descends between the flexor muscles of the fingers to the hand, and contributes to form either the superficial palmar arch or the arteries of the thumb. This is seen particularly when the ulnar artery arises higher than usual, a very remarkable circumstance, as it shows an effort to approximate the anomaly to the normal formation.

§ 1431. The ulnar artery, after giving off the interosseous artery, sends off like the radial, at short intervals, numerous ramuscules, which are distributed to the muscles between which it descends, the flexors of the fingers, and the extensor carpi ulnaris muscle. Near the lower extremity of the ulnar and about an inch above the radial artery, it divides into two branches, the larger of which is the continuation of the trunk, while the other is smaller and is called the *dorsal ulnar* artery (*A. dorsalis ulnaris, ramus dorsalis ab ulnari*). The latter is reflected above the tendon of the flexor ulnaris muscle, on the lower extremity of the ulna, sends branches to the flexor ulnaris and to the pronator quadratus muscle, also to the ligaments of the carpus, anastomoses with the dorsal branch of the radial and with the interosseous artery, gives rise to the dorsal arch of the carpus, and terminates in the fourth internal interosseous muscle, also in the muscles of the index finger, especially the abductor muscle.

§ 1432. After giving some small branches to the palmar ligament of the carpus, the ulnar artery divides, near the posterior extremity of the fifth metacarpal bone, into two branches, the *superficial* and the *deep palmar* artery (*ramus volaris superficialis et profundus.*)

IV. PALMAR ARCHES.

§ 1433. There are two *palmar arches* (*arcus volæ*), a superficial and a deep.

The superficial palmar branch of the ulnar artery is usually much larger than the deep. It passes above the tendons of the flexor muscles which previously covered the ulnar artery, advances immediately below the palmar aponeurosis toward the radial edge of the hand, and anastomoses with the superficial palmar branch of the radial artery, which it always exceeds in volume, even when the latter is unusually large. These two branches join and form the *superficial palmar arch* (*arcus superficialis volæ*). This arch is not unfrequently formed entirely by the ulnar artery which does not then anastomose with the palmar branch of the radial artery, or communicates with it only by some trifling ramuscules.

The *collateral arteries of the fingers* (*A. digitales*) arise from the superficial palmar arch, but not constantly in the same manner. The only rule which we can establish in this respect is, that most of the digital arteries arise directly or indirectly from the superficial arch, from the deep arch, or from both at once, and always arise two and two from a single trunk; so that this single trunk extends from the arch to the

extremity of the first phalanx and there divides into two branches, which are unequal and often disproportional in size, which always belong to two different fingers, and never to one only. These branches proceed on the palmar face of the fingers, along the radial edge of one and the ulnar edge of the other. Each finger thus receives two collateral arteries, the ulnar of which is always the larger.

The little finger usually receives a proper or special ulnar artery, the first branch of the superficial palmar arch which goes to it, proceeding along the flexor minimi digiti brevis muscle, to which it sends numerous ramuscules.

Some distance from this branch, and very near each other, arise three very constant arteries, the second, the third, and the fourth collateral arteries, which go, the first to the radial side of the fifth finger and the ulnar of the fourth, the second to the radial side of the fourth and the ulnar side of the third finger, and the last to the ulnar side of the second and to the radial side of the third.

Farther, we generally find a fourth common collateral artery, which divides into the artery of the radial side of the index finger and the artery of the ulnar side of the thumb.

This arrangement presents only a few unimportant anomalies, the principal of which are:

Sometimes the second collateral artery, the ulnar branch of the fifth finger, belongs not so much to the superficial as to the deep palmar arch, of which it is the posterior part,—that by means of which this arch communicates with the other; so that it must be considered as an anastomosing branch between the two arches. The fourth collateral artery, which goes to the radial side of the third and the ulnar side of the second finger, sometimes presents the same anomaly. These two differences arise because the two arteries always communicate with the deep arch by large anastomosing branches, while the other two middle collateral arteries are more insulated and more independent.

The union of several digital arteries in a common trunk, which is always very short, forms a second anomaly. To this there is a gradual transition by a case which is sometimes observed, viz. the approximation of two branches to each other.

Thus we have often seen coming from a common trunk the first and second, the third and fourth, or the fourth and fifth, which then went only to the radial side of the index finger. When the artery of the little finger does not form a small distinct trunk, but comes from the second, the common trunk is a little longer than that which appears when the branches are united, and the second goes almost always to the ulnar side of the fourth finger, and the radial side of the fifth.

§ 1434. The *deep* or the smallest ulnar artery turns deeply from behind forward on the flexor minimi digiti brevis muscle, goes always outward toward the radial side of the hand, so that it proceeds transversely on the internal interosseous muscle to meet the deep palmar artery, with which it anastomoses, and forms the *deep palmar arch*

(*arcus palmaris profundus*). This arch is sometimes larger and sometimes smaller than the superficial, but smaller more frequently than larger, and its calibre is always greater on the radial than on the ulnar side, because the radial artery concurs to form it more than the ulnar artery. It is always situated farther back than the superficial arch, and is placed directly before the posterior extremity of the metacarpal bones.

§ 1435. The deep palmar arch produces,

1st. From its anterior side or its convexity, the *palmar interosseous* arteries (*A. interosseæ volares*), or the *inferior perforating* arteries (*A. perforantes inferiores*), which are the largest of all its branches.

These arteries go to the internal interosseous muscles in the spaces between the metacarpal bones, give branches to the muscles in these regions, and one or the other at least, and sometimes all, anastomose at their anterior extremity, with the collateral arteries of the fingers, where the latter bifurcate, and also with the superior interosseous arteries.

They correspond to the collateral arteries of the fingers, but are usually much smaller. The first, however, is generally much more developed than the others. Hence we have proposed to term it the *large artery of the index finger* (*A. indicis princeps*) (§ 1425). Sometimes however other arteries among the inferior interosseous arteries are unusually large ; so that they are as large, or nearly as large, as the common trunks of the collateral arteries which arise from the large arch, and the digital arteries also arise as much and even more from the deep than from the superficial arch.

Sometimes, but more rarely, they exceed almost all the collateral arteries of the fingers in volume, and the palmar arteries of the fingers arise more than they from the superficial arch, as is frequently the case with the index and little finger.

2nd. The *superior* or *posterior perforating* arteries (*A. perforantes*, s. *posteriores*, s. *superiores*) arise from the convexity of the deep palmar arch. They penetrate between the posterior extremities of the metacarpal bones, give ramifications to the posterior part of the lumbricales muscles, and come on the back of the hand, where they anastomose with the anterior part of the dorsal arch of the carpus, and with the superior metacarpal arteries, which are given off by this arch less frequently than by them (§ 1432.)

§ 1436. Thus the two palmar arteries concur simultaneously to produce the digital arteries. The superficial arch contributes most to the origin of the palmar branches of the third, of the fourth, fifth, and of the ulnar side of the index finger; the deep, on the contrary, assist more in forming the palmar branches of the thumb and of the radial side of the index finger. Sometimes however the latter arise entirely from the superficial arch, but this is true of the radial artery of the index finger and the ulnar artery of the thumb more frequently than of the radial artery of the thumb. In this case the two branches arise by a common trunk. When all the digital arteries, not excepting those of

the thumb, come from the superficial palmar arch, this divides sometimes at the lower part of the hand into two large principal branches, one of which gives off the twigs which usually arise from the superficial arch, and the other bifurcates to give rise to the principal artery of the thumb and the radial branch of the index finger, which deserves to be remarked, as it shows that nature endeavours to approximate to the normal type, even in the greatest anomaly. The superficial palmar artery of the radius does not then exist, or is very slightly developed. It sometimes, on the contrary, contributes more than usual to produce the superficial palmar arch, and then it gives off also all the digital arteries ; but the ulnar and the radial arteries are not then always connected, except by a small anastomosing branch, which is sometimes entirely deficient, and each of the two arteries produces only the branches which go to the corresponding side of the hand.

The two palmar arteries anastomose at the bifurcation of the digital arteries, and produce the two collateral arteries. They communicate by long branches, which are usually much smaller than the common trunks of the digital arteries. The largest and most constant of these branches are situated between the ulnar artery of the little finger and the common artery of the second and third.

The dorsal arch of the carpus and the deep palmar arch communicate by the posterior or superior perforating arteries and the dorsal interosseous arteries. The last and the inferior interosseous arteries establish a communication between these two arches and the superficial palmar arch.

V. DIGITAL ARTERIES.

§ 1437. Although the digital arteries arise in most cases from the superficial arch (§ 1433), we may however say, that the deep arch (throwing out of view what happens more or less frequently, that some are given off by this latter alone) and the dorsal arch of the carpus contribute to produce them ; so that the obliteration of one of these sources may be easily replaced by the enlargement of the other.

Each finger receives at least four constant branches, two palmar and two dorsal; the latter are smaller than the others. The two palmar branches anastomose on the palmar side, either on one phalanx only, or on several, or even on all, by one or more transverse branches, the convexity of which is turned a little forward. However, among these anastomosing branches, the only ones which are constant are those which are very much developed on the lower face of the third phalanx and which are usually double. Besides, the palmar branches anastomose with the dorsal by an arch on the back of the phalanges, especially the third. Each palmar artery gives off in its course at least ten or twelve branches, which go to the nerves, tendons, ligaments, and skin. It also gives, from the arch it forms at the extremity of the finger,

by anastomosing with that of the opposite side, at least as many ramuscules, which go to the skin.

CHAPTER III.

THORACIC PORTION OF THE AORTA.

§ 1438. From the *thoracic portion of the aorta* or from the *pectoral aorta* (*aorta thoracica*) (§ 1329) arise numerous but very small arteries, and hence the aorta after giving them off is not sensibly smaller than when proceeding along the chest after the three trunks have arisen from its arch.

Many of these branches are constant, but others are not; and they frequently arise totally or at least in part from other arteries.

The former arise from the lateral parts or from the posterior side of the pectoral aorta in its whole length; the others come principally from its upper and central part and from its anterior side.

A. ANTERIOR RRANCHES.

§ 1439. The *anterior branches* of the thoracic artery are principally the *inferior bronchial* (*A. inferiores bronchiales*), the *esophageal* (*A. esophageæ*), and the *posterior mediastinal* arteries (*A. mediastinales posteriores*).

The *inferior bronchial* arteries which arise from the aorta vary much in number and origin.

They vary in number from two to four. There are commonly two on each side of each bronchia. The inferior are a little larger than the superior. The largest and most constant generally arise an inch below the extremity of the arch of the aorta. The right is almost always a branch from the first intercostal artery of the aorta, which gives it off after coming on the right side of the vertebral column, passing behind the esophagus. But sometimes it arises directly from the aorta, and the latter frequently gives off on the right a second inferior bronchial artery when the usual one arises from the first intercostal branch of the aorta, or even when the left bronchial artery sends ramifications to the right bronchia. The left, on the contrary, arises directly from the aorta, and passes before the esophagus to go to its bronchia; but as it is larger than that on the right side, it commonly gives also some branches to the bronchia of the right side.

The small superior bronchial arteries, which are less considerable and inconstant, belong generally speaking more to the left than to the right bronchia.

Besides these ramuscules, which may be called the *middle bronchial* arteries, each bronchia receives from the subclavian artery (§ 1372) or from the corresponding internal mammary (§ 1398), branches, called

the *superior bronchial* arteries, which are expanded in its upper part and communicate by large anastomoses with the middle and inferior bronchial arteries.

Sometimes the aorta gives off only one bronchial artery, which often arises from it in common with the right superior intercostal artery.

The bronchial arteries are distributed not only to the bronchiæ but also in the esophagus, the aorta, the pericardium, and the thymous gland.

§ 1440. The aorta gives off, generally below these arteries, from its anterior part, several esophageal arteries, which vary in number from two to seven, and which are always smaller than the bronchial arteries. These arteries communicate with the esophageal branches which arise from the bronchial arteries and also with others, which are given off by the inferior diaphragmatic arteries, with the latter, and with the arteries of the stomach. They anastomose extensively, and always by very large branches.

1441. The *posterior mediastinal* arteries are always small and very numerous. They are distributed partly in the esophagus and particularly in the parietes of the thoracic aorta, and anastomose with each other, and also with the esophageal arteries, and with the branches of the internal mammary artery.

B. LATERAL AND POSTERIOR BRANCHES. INTERCOSTAL ARTERIES.

§ 1442. The *inferior and posterior aortic intercostal arteries* (*A. intercostales posteriores, inferiores*, s. *aorticæ*) are the lateral and the posterior branches of the thoracic aorta. We find an arterial branch in each intercostal space, but the aorta does not give off as many as there are spaces; for, 1st, the first and second, or at least the first, usually receive their vessels from the superior intercostal artery, a branch of the subclavian artery (§ 1399).

2nd. Several intercostal arteries, particularly the upper and the lower, and sometimes also the middle, although then the upper and lower do not participate in the anomaly, arise by common trunks, both the opposite arteries of the right and left sides, which correspond in respect to the intercostal space into which they penetrate, as well as those which are situated one above the other on the same side. This last anomaly is more rare than the first. When two intercostal arteries arise by a common trunk, we have always observed hitherto that the inferior is the continuation of the trunk, and proceeds in its direction, while the superior generally passes before and more rarely behind the neck of the rib to arrive at the intercostal space, in which it is then distributed as usual.

A common trunk usually divides only into two secondary branches, but sometimes also it gives off several, of which the superior aortic intercostal artery * gives frequent examples.

* In opposition to the superior intercostal, which arises from the subclavian artery.

The fact that the superior and inferior intercostal arteries generally arise by a common trunk, is curious in two respects :—

1st. Because it furnishes a new instance of the resemblance between the upper and the lower extremities of the same region.

2nd. Because the superior aortic intercostal artery and the superior intercostal which arises from the subclavian artery, especially correspond.

The two arrangements are then a repetition, in the central portion of the vascular system, of the resemblance demonstrated between the upper and the lower part of this system, when we consider the diaphragm as the line of demarkation between the two portions.

Finally, the two series of intercostal arteries are not perfectly similar, and the two intercostal spaces of one side frequently receive their vessels from a common trunk, while on the other side they arise separately.*

We generally find on each side eight† aortic intercostal arteries because the upper intercostal artery gives them to the first two intercostal spaces, and the third and fourth receive the blood from the branches of the first aortic intercostal artery.

The number of the intercostal arteries is very rarely increased by one, which happens when the upper intercostal artery, usually furnished by the subclavian, arise directly from the pectoral aorta.‡ This is more frequently the case than that the first aortic intercostal artery is distributed only in the third intercostal space.

The number of these arteries is then one less, and is reduced to seven. Then sometimes the first goes to the second, third, and fourth intercostal spaces ; sometimes, and more frequently, two of the inferior arise by the same trunk.

All the intercostal arteries generally come more from the back side of the aorta than from its lateral part, they arise near each other, and the right and the left at the same height.

They are all detached from the aorta at slightly acute angles, and go upward toward the intercostal space to which they correspond, passing on the bodies of the vertebræ and the necks of the lower ribs.

The distance between their origin and their intercostal space is much greater, and the angle which they make with the trunk is more acute above and more obtuse below in the upper than in the lower. They never, not even the lowest, form a right angle with the aorta.

* Bichat is mistaken in saying that, considered on the two sides, these arteries are almost perfectly similar (*An. descript.*)

† Bichat asserts erroneously, that there are usually nine. Murray and Sœmmerring are also mistaken in saying there are never less than eight. Mayer is still more in the wrong; he admits that there are usually eleven aortic intercostal arteries on the right side, and ten on the left.

‡ Monro seems to regard this formation as equally common with the rule (*Outlines*, p. 322) ; but it is in fact very rare, a circumstance which is not uninteresting, inasmuch as the pectoral aorta seems to have, directly above the origin of the intercostal artery, a great tendency to contract very much, or to close entirely.

These arteries become smaller in proportion as they are lower. It is however necessary to say something more exact on this subject. In fact the first intercostal artery is much larger than the others, partly because it is distributed to a greater number of intercostal spaces, and because on the right side at least it gives rise either partly or wholly to the right bronchial artery.

The right intercostal arteries, from the situation of the aorta on the left side of the vertebral column, are longer than the left, by all the right portion of the vertebræ on which they pass.

Near their origin, they give ramifications to the esophagus and generally to all the parts contained in the posterior mediastinum, and divide usually near the head of the ribs into two branches, a *posterior* and an *anterior*.

The *posterior* branch (*R. posterior*, s. *dorsalis*) passes through the intercostal space to go backward, gives some ramuscules to the vertebræ, also sends some to the spinal marrow, through the intervertebral foramina, but is distributed principally to the posterior muscles of the trunk situated in the groove between the vertebral column and the ribs, the multifidus spinæ and the longissimus dorsi. Its superficial ramifications reach even to the skin, and it anastomoses by ascending and descending branches with the adjacent superior and inferior dorsal branches.

The *anterior*, *thoracic*, or *intercostal* branch (*R. anterior*, *thoracicus*, *intercostalis*) is generally much larger than the dorsal, which exceeds it particularly in volume in the superior intercostal arteries, and which, from its direction, may be considered as the continuation of the trunk; it proceeds first between the pleura and the posterior part of the intercostalis internus muscle, to which it is feebly united, then passes between the intercostales interni and externi muscles, and soon divides into two branches.

The *inferior* branch (*R. costalis inferior*) is much smaller than the other, goes forward, along the upper edge of the lower rib, soon passes on the internal face of this bone, gives ramifications to its periosteum, furnishes some, although very few, to the intercostales muscles, and terminates by anastomosing with the upper branches of its trunk and of the intercostal artery which come directly after.

The *upper* branch (*R. costalis superior*) is the continuation of the trunk, and proceeds below the upper rib of its intercostal space in the groove, on its lower edge, goes forward, gives ramuscules to the ribs, to the intercostales, the abdominal, and the dorsal muscles and to the diaphragm, and anastomoses with the anterior intercostal arteries which come from the internal mammary artery, and also with the epigastric and the external iliac arteries.

The first intercostal artery is distinguished from the others by the characters we have already mentioned. It supplies several, and sometimes even three intercostal spaces.

The right and left differ, as the first usually gives off the right bronchial artery while the second is distributed more frequently than it in a third intercostal space.

Although this latter arrangement is not constant, we have never seen the first two intercostal arteries correspond in regard to the former.*

Next to the first the last is largest of any, and somtimes exceeds it in size. It arises behind the lumbar portion of the diaphragm; after giving some branches to this muscle it passes almost entirely below and before it, and, proceeding outward and forward, behind the upper portion of the quadratus lumborum muscle, it divides into several large branches, which are distributed in this muscle and also the broad muscles of the abdomen, then descend to the crest of the ilium, and anastomose frequently with the lumbar and with the circumflex iliac arteries.

The two inferior intercostal arteries often arise by a single trunk, which comes from the posterior part of the aorta. They are sometimes deficient on one or on both sides; they are then replaced by the first lumbar artery.

CHAPTER IV.

ABDOMINAL PORTION OF THE AORTA.

§ 1443. The abdominal aorta gives off in fact fewer branches, but most of them are larger than those which arise from the thoracic aorta. The reason of this is that the abdomen is larger than the chest, and the organs which it contains are also much larger. A farther reason is that all these organs receive their arteries from the abdominal aorta, while those of the thoracic viscera do not all come from the thoracic aorta.

The branches of the abdominal aorta may be divided into anterior, lateral, and posterior. The anterior and the posterior are however, at least in great part, sometimes more and sometimes less lateral than usual.

I. ANTERIOR BRANCHES.

§ 1444. The *anterior* branches of the abdominal aorta belong almost exclusively to the digestive organs. There are usually three, the *cœliac*, the *superior*, and the *inferior mesenteric* arteries. Sometimes

* As Sœmmerring seems to admit (p. 249), since he thinks that the first two intercostal arteries are large because they give off the bronchial arteries. Bichat agrees with us (p. 250) on this subject.

however we find only two, the first arising by a common trunk. But they oftener exceed three.

The aorta on coming into the abdomen, having passed through its opening in the diaphragm, usually gives some small branches to the pillars of this muscle, to the thoracic canal, and to the renal capsules.

It seldom gives off the inferior diaphragmatic arteries, either separately or by a common trunk. These arteries more frequently arise from the cœliac artery, consequently they will be treated of when speaking of that artery.*

I. CŒLIAC ARTERY.

§ 1445. The *cœliac* artery, *Opistrogastrique*, Ch. (*A. cœliaca*),† is usually the largest, and arises the highest, as it comes off at a right angle from the aorta, between the pillars of the diaphragm.

Usually and in fact almost always, when its trunk is not exceedingly short, it gives off first, from its upper side, the *superior diaphragmatic* arteries (*A. diaphragmaticæ*, s. *phrenicæ majores*, s. *principes*, s. *inferiores*), which arise sometimes separately and sometimes by a very short common trunk. Sometimes one of these arteries comes from the aorta and the other from the cœliac artery; more rarely one or both of them are given off by one of the branches of the cœliac, or even by the renal, or finally by the inferior capsular artery. They ascend directly on the pillars of the diaphragm, to which they give off branches and also supply the *middle capsular* arteries (*A. suprarenales mediæ*), which go to the renal capsules; and when they have arrived at the upper extremity of the pillars, divide into an anterior and a posterior branch.

The *posterior* branch, which is the smaller, is sometimes, at least on one side, given off wholly or partially by the aorta. Even when the principal trunk arises from the cœliac artery, it sends considerable branches to the renal capsules; these are called the *superior capsular* arteries (*A. suprarenales superiores*). It then goes outward, below and behind the tendinous centre of the diaphragm, to be distributed principally in the lumbar portion of this muscle.

The anterior branch is much larger, and must be considered as the continuation of the trunk; it goes forward, along the esophagœal opening, before which it divides into two branches, an anterior and internal, and transverse which is much smaller, and is distributed to the central portion of the diaphragm, and anastomoses with that of the

* Monro is mistaken in saying that these arteries arise from the aorta (vol. iii. p. 335). Mayer (p. 656) also seems to think this is the most common arrangement. Murray (p. 61) and Soemmerring (p. 252) think that they arise from the aorta as frequently as from the cœlic artery. Bichat is more correct (p. 283,) in saying that they arise from the cœliac artery more frequently than from the aorta. This remark was made long before him by Haller, (part 2, notes to vol. i. p. 6).

† A. F. Walther, *De arteriis cœliacis*, Leipsic, 1729.

opposite side, while the external is much larger, goes outward, and gives ramuscules to most of the costal portion of the diaphragm.

The inferior diaphragmatic arteries go principally to the lower face of the central portion of the diaphragm. They communicate with the external which arise from the internal mammary, with the inferior intercostal, and the lumbar arteries; also pass through the diaphragm, enter the chest, and give off, in this cavity, the pericardiac and the inferior mediastinal arteries.

§ 1446. The cœliac trunk after and sometimes also before giving off the inferior diaphragmatic arteries divides most generally into three branches; these are the coronary arteries of the stomach, the hepatic and the splenic artery. These three branches form the *tripus Halleri.*

§ 1447. The *coronary artery of the stomach, Stomogastrique*, Ch. (*A. coronaria ventriculi*, s. *gastrica superior, major sinistra, gastro-hepatica sinistra*), is usually much smaller than the other two branches of the cœliac artery. Sometimes, but rarely, it arises from the aorta before the latter, either alone or by a trunk which is common with it, sometimes with only one of the inferior diaphragmatic arteries, particularly that of the left side, and sometimes with both.

It proceeds first upward and forward, then to the left, and gives off,

1st. Several *inferior esophagæal* arteries (*A. esophageæ inferiores*).

2nd. Several *posterior cardiac* arteries (*A. cardiacæ posteriores*), which are distributed around the superior orifice and on the large curvature of the stomach, and descend principally on its posterior face.

3rd. Very frequently, and even almost always, the left hepatic artery.*

The anterior and superior gastric and the other inferior esophagœal arteries, arise from this artery or from the following branch.

4th. The *gastric* branch (*R. gastricus*). When the coronary artery of the stomach gives off the left hepatic artery, it bifurcates to give origin to it and also to the gastric branch. The latter usually divides into several large *anterior* and *posterior* ramuscules, which are distributed on the anterior and posterior faces of the stomach, and anastomose with each other and with the preceding. It always gives off a greater or less anastomosing branch, which follows the small curve of the stomach, and goes toward the right side, where it anastomoses with the pyloric artery.

§ 1448. The *hepatic* artery (*A. hepatica*) is larger than the preceding. Sometimes it does not give off the usual number of branches. The anomaly may then occur in several different ways. In fact the hepatic artery is sometimes divided into two trunks, which arise one from the cœliac artery as usual, the other from the coronary artery of the stomach, or from the superior mesenteric artery, or more rarely from

* Hence the term *gastro-hepatic* which has been applied to it. In this case the coronary artery of the stomach is not, as generally, much smaller than the other two branches of the cœliac artery, but it is often as large as the hepatic, especially when it gives off at the same time one or both of the inferior diaphragmatic arteries.

the aorta; sometimes there are three trunks, one of which arises from the cœliac, a second from the superior mesenteric artery, a third from the aorta.

Sometimes but more rarely the hepatic artery arises entirely from the aorta. The rarest anomaly is that where it comes entirely from the superior mesenteric artery.*

The trunk of the hepatic artery proceeds transverely to the right side; it then goes a little obliquely forward and upward, entering into the transverse fissure of the liver.

Just before arriving at the liver it divides into two branches, the right gastro-epiploic artery and the hepatic branch.

§ 1449. The *right gastro-epiploic* artery (*A. gastrica dextra inferior, coronaria ventriculi dextra inferior, gastro-epiploica dextra, pancreatico-duodenalis*), which is much smaller when only one hepatic trunk exists, but which in other cases is as large as the hepatic branch, goes downward, and to the left, toward the origin of the duodenum, passes below this intestine, between it, the pylorus, and the pancreas, reaches the great curvature of the stomach, proceeds along it from right to left, and anastomoses with the left inferior gastro-epiploic artery.

In its course it gives off the following branches:

1st. Before arriving at the duodenum and passing under this intestine, one or two considerable branches, the *pancreatico-duodenal* arteries (*A. pancreatico-duodenales*), which descend along the concavity of the duodenum, give to it numerous ramuscules, and also give origin to one or two retrograde *pyloric* arteries (*A. pyloricæ inferiores*); the latter, which are distributed around the pylorus, give off other considerable branches to the head and to the right portion of the pancreas, and anastomose extensively with the branches of the superior mesenteric artery.

One or more of these anastomosing branches are sometimes so large that we might consider the right gastro-epiploic artery rather as a branch of the inferior mesenteric than as arising from the cœliac artery.

2nd. The continuation of the trunk proceeds along the large curvature of the stomach, gives a great number of ascending branches to the two thirds on the right of this viscus, and sends others which are less numerous, and which descend between the two layers of the large epiploon, where they form the *right* and *middle epiploic* arteries (*A. epiploicæ dextræ et mediæ*). These branches anastomose with each other and with those of the left gastro-epiploic artery by large arches.

Near the commencement of the left third of the stomach the trunk of the right gastro-epiploic artery gradually diminishes and becomes very small, so that we can easily perceive the limit which separates it from the left gastro-epiploic artery, with which it anastomoses in this place.

* Haller, *Ic. anat.*, part viii. p. 36.

§ 1450. From the *hepatic* branch (*R. hepaticus*), sometimes also from the trunk of the hepatic artery, before it gives off the right gastro-epiploic artery, arises a smaller branch, called the *superior pyloric* artery (*A. gastrica dextra superior, coronaria ventriculi dextra superior, pylorica superior*). This branch descends towards the pylorus and anastomoses with the inferior pyloric, and with the branches of the left gastro-epiploic by small arches.

Soon after the hepatic branch divides into a right and left.

The *right hepatic* artery (*A. hepatica dextra*) is larger than the left. It is distributed to the right lobe of the liver and to the gall-bladder.

This soon divides into two branches; the smaller goes to the middle part of the liver (*A. hepatica dextra minor, A. hepatica media*); this sometimes arises directly from the aorta, although the origins of all the other branches are normal; the other is greater and is the continuation of the trunk. The latter goes to the vena-porta, enters the transverse fissure of the liver, where it divides into numerous ramifications, and almost always gives off, just before entering, one or two *cystic* arteries (*A. cystica*).

The right hepatic artery, either alone or with the right gastro-epiploic artery, not unfrequently arises from the superior mesenteric artery, an arrangement always indicated by the large anastomoses between these two arteries by means of the pancreatico-duodenal arteries. The left hepatic artery, not unfrequently, is separated from the right, and arises from the tripus Halleri by a common trunk with the coronary artery of the stomach.

§ 1451. The *splenic* artery (*A. splenica*, s. *lienalis*) is the largest of the three branches of the cœliac artery in the adult, and goes to the left soon after arising, proceeding below and behind the stomach in the transverse fissure of the pancreas.

In this course it gives off,

1st. From its lower side the *middle* and the *left pancreatic* arteries (*A. pancreaticæ mediæ et sinistræ*), which vessels are usually large and arranged in an arch; they go from right to left on the pancreas, and from their convexity arise numerous anterior and posterior branches which penetrate from below upward into the pancreas.

2nd. More to the left, five or six *short gastric* arteries arise (*A. gastricæ breves*, s. *fundi ventriculi*). These almost always make a part of the numerous branches into which the trunk of the splenic artery divides before entering the spleen.

These vessels retrograde toward the left large extremity of the stomach, and communicate on its two faces, by numerous anastomoses, with the coronary and right gastro-epiploic arteries.

We observe a lower branch, which is large; this is the *left gastro-epiploic* artery (*A. gastrica*, s. *coronaria sinistra inferior, gastro-epiploica sinistra*); this descends along the great curvature of the stomach, usually anastomoses very evidently with the right gastro-

epiploic artery, and gives off large branches, the left epiploic arteries, to the large epiploon.

II. SUPERIOR MESENTERIC ARTERY.

§ 1452. The *superior mesenteric* artery (*A. mesaraica*, s. *mesenterica superior*) is generally a little and often considerably larger than the cœliac artery, when the latter arises partly from the aorta or from the superior mesenteric artery, and generally comes from the trunk of the aorta directly below the cœliac trunk. It not unfrequently arises with it by a common trunk, which is sometimes nearly an inch long*—a curious arrangement, as it resembles the formation of the tortoise.

The artery is covered first by the pancreas, and descends perpendicularly behind it on the lower part of the duodenum. It passes between the two layers of the mesentery, and near its centre describes a considerable curve, the convexity of which looks forward and downward to the left while its concavity is turned to the right backward and upward. The centre and upper part of this curve is much farther from the small intestine than its lower portion; it gradually diminishes and terminates on the right and downward in the right lumbar region.

All the constant branches of the superior mesenteric artery arise from this curve, which furnishes blood to a part of the pancreas, to all the small and most of the large intestines, especially to its right and transverse portions. The first branches go to the pancreas and to the duodenum; the next go to the large intestine; and the inferior to the small intestine. The first anastomose with the hepatic artery, more rarely also with the coronary artery of the stomach.†

The *arteries of the small intestine* (*A. intestinales*), which come from the convexity of the curve of the superior mesenteric artery, deserve to be mentioned before the others,‡ because the first of them arises higher than those which come from the concavity, and the study of the latter naturally leads to that of the branches which come from the inferior mesenteric artery.

The superior intestinal arteries are usually the longest; the first is however a little shorter than the following, but the last or the lowest are shorter than the others and also the smallest.

We generally number from sixteen to twenty; but we must reduce this number to ten or eleven, as it is more correct to consider the lowest, not as distinct trunks, but as secondary branches of the last branch,

* Haller considers this arrangement as a rare anomaly, because he has observed it only once; (*Ic. anat.*, part viii. p. 35, no. 11). We however think it more common, for we have seen it five times, although we did not look for it particularly in the cadavers we examined.

† Barclay, *loc. cit.*, p. 182.

‡ This method has been followed correctly by Mayer (*Ang.*, p. 170), and Monro (*Outlines*, p. 335); but not by Murray (p. 68), Sœmmerring (p. 267), and Bichat.

which in going from left to right and from below upward anastomoses with the last of the branches which arise from the concavity.

If we follow the usual method, the intestinal arteries are almost always more than twenty in number, and the last eight or nine are extremely small and short.

These arteries diminish from above downward in respect to their diameter; we however find among the largest some which are very small, although they also arise from the trunk of the mesenteric artery.

They all proceed between the two folds of the mesentery to the intestine, distributing in their progress numerous branches to this membrane and also to the mesenteric glands. They usually divide into an upper and a lower branch. This division occurs sooner or later, in proportion as the branches are shorter or longer. These branches anastomose with the opposite branches of the adjacent arteries and form a large arch, composed of as many smaller arches as there are intestinal arteries; the convexity of this arch always looks toward the concavity of the small intestine. The two branches do not suddenly unite, but anastomose at a proportionally short distance from the intestinal canal.

Numerous secondary ramifications arise from the convexity of these arches; these are very compactly situated and very frequently anastomose. Hence results a much more extensive external arch, composed of a still greater number of small arches, whence arise numerous ternary branches. These also bifurcate two or three times, and anastomose in the same manner, at least where the intestinal arteries are larger.

These vessels represent by their division a very coarse net.

Finally, from the external surface of this net arise numerous arterioles, which are divided into an anterior and a posterior series, which go to the intestinal canal, and are distributed on its internal membrane after still more subdivisions and anastomoses.

A minute description of their distribution in the intestine will be given after that of the intestinal canal more properly than in this place.

§ 1453. From the concavity of the curve of the superior mesenteric artery, nearly opposite the place where the third, fourth, fifth, and sixth intestinal arteries arise, and about an inch from each other, are constantly given off at least two, and almost as often or at least not very unfrequently three branches, which belong exclusively to the colon, particularly to its right portion; these may be called the *right colic* arteries (*A. colicæ dextræ*). Of these branches the centre is usually smaller than the other two, and generally it arises nearer the superior.

§ 1454. The lowest, which goes to the right outward and downward, is called the *inferior right colic* or the *ileo-colic* artery (*A. colica inferior dextra, ileo-colica*). Some distance from its origin it sends downward a branch, which anastomoses with that which we have considered as the last intestinal artery and which is generally regarded as the trunk of the superior mesenteric artery, uniting with this artery a little before it terminates, partly also proceeds as the artery of the *cæcal appendix*

(*A. appendicalis*) to the vermiform appendage of the cœcum, along which it re-ascends to its extremity, giving off from its convexity a great number of branches, which arise at acute angles.

It afterwards immediately divides into an ascending and a descending branch.

The descending branch, the *cœcal* artery (*A. cœcalis*), sends a large anastomosing ramuscule to the last intestinal artery or to the extremity of the curve of the superior mesenteric artery, and afterwards divides into two other secondary branches, the *anterior* and the *posterior cœcal* artery, which are distributed in the corresponding parts of the cœcum and anastomose with the artery of the cœcal appendix.

The *ascending* or *anastomosing branch* (*R. ascendens*, s. *anastomoticus*) ascends at a short distance from the concave part of the intestinal canal along the ascending colon, to which it gives off numerous branches, but however equal in number to those of the intestinal arteries, which also anastomose less frequently. These branches divide near the colon into ramuscules, forming an anterior and a posterior series, all of which are distributed to the parietes of this intestine.

§ 1455. The *middle right colic* artery (*A. colica dextra media, colica dextra, colica dextra inferior*) is always the smallest of the three branches which arise from the concavity of the curve of the mesenteric artery, and often comes from the superior. Sometimes but very rarely it is given off by the inferior right colic artery.* It usually commences very near the superior colic artery.

When it is given off by the latter, it generally arises at the place where it anastomoses, when it comes from the mesenteric artery, with the superior colic artery by a short but very large branch; so that when it forms a distinct trunk we should consider it as an anastomosing branch between the superior right colic artery and the trunk of the superior mesenteric artery.

When it is a branch of the superior mesenteric artery, it divides at some distance from its origin into a superior and an inferior branch.

The superior ascending branch is much shorter and anastomoses with a similar branch from the superior right colic artery.

The inferior descending branch is much larger, goes along the concavity of the ascending colon, and anastomoses by a large arch with the ascending branch of the inferior right colic artery.

This artery supplies the middle part of the ascending colon with blood.

§ 1456. The *superior right colic* artery (*A. colica superior dextra, colica media*, s. *anastomotica dextra*) generally arises some inches below

* Bichat seems to doubt this fact, but wrongly. He says that the inferior colic artery is constantly distinct. Murray and Mayer do not mention it, although they correctly state that the two superior right colic arteries not unfrequently form a trunk. Sabatier and Soemmerring are more correct in saying that the two superior right colic arteries rarely arise together. Others, as Portal and Monro, mention only the cases where the three arteries form three distinct trunks.

the origin of the trunk and as high as the transverse meso-colon. It afterwards enters between the two layers of the peritoneum, goes directly forward toward the centre of the transverse colon, and divides into a right and a left branch.

The right branch is generally a little smaller than the other, is also shorter, and anastomoses with the ascending branch of the middle right colic artery, which it sometimes replaces entirely (§ 1455).

The *left branch* (*R. anastomoticus magnus*) passes behind the left and largest portion of the transverse colon, communicates with the ascending branch of the left colic artery given off by the inferior mesenteric artery, and forms with it the largest anastomosis found in the adult. This anastomosis is seldom deficient.

This artery is distributed to the upper part of the ascending, and to the central and right portions of the transverse colon.

§ 1457. One branch of the superior mesenteric artery, which exists only in the early periods of life, is the *omphalo-mesenteric* artery (*A. omphalo-mesaraica*), which generally arises from this trunk, but in no determinate place; this artery, accompanied by the veins of the same name, leaves the mesentery, passes on the lower part of the small intestine, arrives at the umbilicus, comes from the abdomen with the intestine, enters into the umbilical sheath before the end of the second month of pregnancy, and extends to the umbilical vesicle, and distributes its ramifications on its surface. This branch constantly exists until the end of the second month, after which it is almost always obliterated and is visible only in the mesentery and near the umbilicus. Sometimes it continues, always preserving rather a large calibre, and extends with its accompanying vein to the umbilical ring or even into the cord. Sometimes it is obliterated, but extends from the intestine to the umbilicus. These two cases occur principally when the intestinal canal, either alone or with other organs, is arrested at one of the first degrees through which it passes successively in its formation. The omphalo-mesenteric artery is undoubtedly the largest of those in the fœtus.

III. INFERIOR MESENTERIC ARTERY.

§ 1458. The *inferior mesenteric* artery (*A. mesaraica*, s. *mesenterica inferior*) comes from the aorta, generally some inches lower than the preceding, and usually about an inch above the bifurcation of the trunk of the aorta where the two primitive iliac arteries arise.

The only exceptions are when several renal arteries existing, one of them arises very low and the mesenteric artery is constantly given off from the aorta above the latter; its description however should precede theirs, because it comes from the anterior part of the trunk of the aorta, and because it is distributed to the intestinal canal, as are all the other arteries which arise in like manner from the anterior side of the abdominal aorta.

Still more rarely it comes from the primitive iliac artery,* which appens when the aorta bifurcates higher than usual.

It is always a little smaller than the renal arteries, proceeds obliquely) the left and upward under the peritoneum, penetrates immediately etween the layers of the iliac meso-colon, and divides into several anches, which belong only to the left portion of the colon and to the ctum, the upper of which may be called the *left colic* arteries (*A. co- æ sinistræ*), to distinguish them from the right (§ 1456) which arise om the superior mesenteric artery, while the lower go to the rectum id are called the *upper hemorrhoidal* arteries (*A. hemorrhoideæ supe- ores*).

This artery is rarely deficient,† a remarkable anomaly, which sembles the normal formation of many animals, viz. birds and rep- es, in which the posterior mesenteric artery gradually diminishes d entirely disappears.

§ 1459. The *left colic* arteries (*A. colicæ sinistræ*) arise from the per convex part of the inferior mesenteric artery. We sometimes d two or three, a superior, middle, and an inferior. The middle is metimes blended with the superior and sometimes with the inferior. he first case is more common.

The *superior left colic* artery (*A. colica sinistra superior, anastomotica istra*), generally the larger, proceeds along the descending colon d divides into two branches. This division occurs sometimes imme- tely, when it gives off the middle colic artery, sometimes later, en this arises separately from the mesenteric artery or by a com- n trunk with the inferior.

In the second case one branch goes to the right, the other to the side. The latter anastomoses with the left branch of the superior ht mesenteric artery, behind the left portion of the transverse colon, l thus forms a large arch (*arcus anastomoticus magnus*), (§ 1456) produce which however it but slightly contributes. This anasto- ses, in front of the upper part of the descending colon, with the ending branch of the middle left colic artery.

The *middle left colic* artery (*A. colica sinistra media*) sometimes forms lower branch of the preceding; and then arises from it very early, more frequently is a distinct trunk, which soon after divides into branches, the larger of which ascends along the left colon, and stomoses with the descending branch of the superior left colic ery; and the inferior communicates with the ascending branch of inferior left colic artery.

The *inferior left colic* artery (*A. colica sinistra inferior*), which is ributed to the lower part of the descending colon, divides still sooner two branches, which anastomose, the ascending with the descend- branch of the middle left colic artery, and the descending with the ending branch of the superior hemorrhoidal artery.

* Petsche, *Syll. obs.*; in Haller, *Coll. diss.*, vol. vi. p. 761.
† Fleischmann, *Leichenöffnungen*, 1815, p. 239.

§ 1460. The *superior hemorrhoidal* artery (*A. hemorrhoidea superior*, s. *interna*) arises from the concavity of the curve described by the inferior mesenteric artery. It would then be more correct to consider it as the inferior of the two branches, into which this artery often divides, and the upper of which furnishes the left colic arteries.

It goes to the right, and descends behind the rectum, distributing its branches to most of this intestine. It usually divides into two branches, the upper of which is smaller, and the lower larger, and is the continuation of the trunk. Each branch immediately divides, although at some distance from the rectum, into a right and left, which open together downward and beside each other by considerable anastomoses, and are distributed to the rectum, where their branches usually communicate with those of the vesical and uterine arteries.

We shall mention the difference in the arrangement of the arteries of the small, and those of the large, intestine, when treating of the intestinal canal.

II. LATERAL BRANCHES.

§ 1461. The lateral branches of the abdominal aorta are the *middle capsular*, the *renal*, and the *spermatic* arteries.

I. MIDDLE CAPSULAR ARTERIES.

§ 1462. The *middle capsular* arteries (*A. capsulares mediæ*) are one, two, and sometimes even three, in number, and arise from the aorta very near each other, usually above, sometimes below, and a little in front of the renal arteries. In some subjects they come from the cœliac or from the renal arteries. They go to the right and left, passing on the bodies of the vertebræ, and arrive from below upward on the posterior face of the renal capsules, but at the same time they send branches to the pillars of the diaphragm, and to the lymphatic glands in the lumbar region.

II. RENAL ARTERIES.

§ 1463. The *renal* or *emulgent* arteries (*A. renales*, s. *emulgentes*) come entirely from the side of the aorta, directly below the superior mesenteric artery. They arise at a right or at an almost right angle; they proceed from before backward and from within outward, directly on the lateral faces of the bodies of the first or second lumbar vertebra, and, arrived at the kidney, penetrate into its fissure after dividing, most frequently near this organ, into several and generally into three branches, which also subdivide before entering its substance.

They arise almost opposite each other; the right however is a little lower than the left, because the kidney of this side is lower than that of the other. To this law however there are exceptions. We remark

particularly that when the right renal artery is double, the superior usually arises a little higher than the single renal artery of the left side.

These arteries are very large, but not, as Bichat says, the largest in the abdomen, since they are smaller than the cœliac or the superior mesenteric artery.

§ 1464. The renal arteries present many anomalies. The most usual affect their number. We generally find only one renal artery on each side. This number however is frequently, in fact often, increased by reducing the branches into distinct trunks, which arise directly from the aorta. The transition to this arrangement is marked by that where the single renal artery early divides into branches: this early division is not unfrequent, and often occurs only on one side; the renal artery of the opposite side being already divided into several separate trunks.

This anomaly of the renal arteries differs—

1st. In the conditions of its occurrence; 2nd, in the number of divisions it produces; 3rd, in its occurrence on one or both sides; 4th, in its being more frequent on one side than on the other; 5th, in the proportional size of the separate trunks; 6th, in their place of origin; 7th, in their insertion; 8th, in their relation with the renal veins.

1st. The conditions in which the number of the renal arteries is increased are—

a. An unusual size of the kidneys.

b. Their unusual length, although their size is not much increased. In this case their central portion is often strangulated.

c. The union of the two kidneys.

d. Their unusually low situation in the pelvis.

2nd. In respect to number. The renal arteries are increased by one more commonly than by many.

Sometimes however there are three, four, and even five on one side.

3rd. In regard to the simultaneous existence of several renal arteries on both sides at once, we remark generally that when there are not more than two, the anomaly occurs on one side as frequently as on both. When however this increase is more than two, it is rarely confined to a single side, although it very seldom occurs on both sides in the same degree. This rule however is not general, since four renal arteries sometimes exist on one side and only one on the other.

4th. The anomaly does not seem to affect one side of the body more than the other. This remark is the result of our own observations; it however is confirmed by the difference in the assertion of authors on this subject. Some say that the anomaly is more frequent on the left and others on the right side.

5th. The anomaly is the least possible when one of the two renal arteries is much smaller than the other. The larger then is generally but not always the upper; it forms the normal trunk. In fact the

supernumerary renal arteries not unfrequently have the same caliber, each of them, considered separately, being a little smaller than the normal artery, except when one kidney is larger than the other.

6th. The supernumerary renal arteries also vary much in their origins. The nearest to the normal formation is where the second renal artery arises directly at the side of the normal artery; but they are frequently very distant from each other, so that one or some of them not only arise from the aorta, below the inferior mesenteric artery, but also come from the primitive iliac or even from the hypogastric artery; the last two cases, however, usually occur only when the kidneys are blended together or are situated very low. But if we except those cases where the kidney is situated very low, one renal artery generally arises from the usual place, however remote may be the origin of the others.

When more than two renal arteries exist, one generally arises very far from the rest. Sometimes they are situated at equal distances from each other. Sometimes also when four occur two of them arise very high, and two very low.

7th. The place of insertion is more abnormal, the lower the origin of the renal arteries, and the greater the anomaly in the form and situation of the kidneys. If the arteries are given off very low, although the situation of the kidneys is normal, they frequently do not enter its fissure, but are inserted at its lower extremity. If the kidney is situated very low, the vessels usually converge from all sides to enter it.

8th. The relation between the renal arteries on one side, and the emulgent veins and the vena-cava on the other, may be regarded in twopoints of view:—

1st. In regard to their simultaneousness and frequently. A series of careful observations permit us to establish as a principle that the veins divide much more rarely than the arteries, and consequently the veins are not always abnormal, in this respect, when the arteries are, although this is somewhat common, even when the arteries exist, in regard to these two orders of vessels at the same time; the number of renal arteries nevertheless frequently exceeds that of the emulgent veins, although sometimes, but rarely, the veins alone are abnormal.

2nd. Usually, particularly when more than two renal arteries exist, the relation of the situation with the veins is changed in this respect, that one or both of them pass before and not behind the vena-cava inferior to go to the kidney. One easily perceives that this rule can apply only to the renal arteries of the right side.

The two renal arteries much more rarely arise from the anterior face of the aorta by a common trunk which, in the only case of this anomaly known to us, was inserted very near the mesenteric artery.

Other anomalies relate to the side of the vascular system whence the renal vessels arise. Each renal artery generally goes to the kidney of the same side. The only exception to this rule is when the kidneys exist in the pelvis; one of the renal arteries then not unfre-

quently arises from the primitive iliac, or from the hypogastric artery of the opposite side.

§ 1465. Beside these slight and inconstant differences between the renal arteries of the two sides, in respect to the height at which they arise, they are constantly distinguished from each other by their length; that of the right side being longer than the other, and more so because the aorta is situated more to the left. In its course to the kidneys it usually passes behind, but not unfrequently before the ascending vena-cava.

The renal arteries belong particularly to the kidneys and enter almost wholly into the fissure. Proceeding, however, they always give several greater or less branches. These are,

1st. The *inferior capsular* artery (*A. suprarenalis inferior*) almost constantly arises from the renal artery, or at least comes very rarely from the aorta itself with the middle capsular arteries. This artery is even sometimes double, since, beside the usual artery, that which directly arises from the origin of the renal artery, a smaller one exists, which comes from one of its branches.

This inferior capsular artery is not unfrequently very large. In this case it gives off branches to the lumbar portion of the diaphragm, and sometimes the whole inferior diaphragmatic artery comes from it.

2nd. The branches which go to the pelvis of the kidneys and to the ureters.

3rd. Rarely, and most generally on the left, and even then usually only where several renal arteries exist, the *spermatic* artery, which in this case constantly arises from the inferior renal artery. We have however satisfied ourselves that when the renal artery divides into several branches, the spermatic artery is by no means always inserted in one of the latter.

4th. Some branches to the renal capsule. These ramifications enter nto the substance of the kidney, and there are likewise some small branches which go from the substance of the kidney to the capsule.

5th. More rarely the right renal artery sends a branch to the lower part of the liver.

III. SPERMATIC ARTERIES.

§ 1466. The *spermatic* arteries (*A. seminales*, s. *spermaticæ*) are usually single but not unfrequently double. They generally arise a little but sometimes far above the renal artery. They rarely originate opposite each other; one is frequently detached much higher than the other and much more before it, and most generally before the middle capsular arteries, making with the aorta an acute angle. Frequently also the spermatic artery on one side (§ 1464) arises from the renal, or from the inferior or middle capsular artery. More rarely it arises from the lumbar, from the external iliac, from the hypogastric, or even from the epigastric artery of its side. It generally extends vertically

downward, but sometimes also it turns on the renal vessels before assuming its downward and outward direction, which it follows and keeps it directly behind the peritoneum, and before the ureter, which it crosses. That of the right side also passes before the vena cava inferior.

The spermatic artery is much shorter in the female than in the male, since it does not leave the abdomen, and is distributed to the ovaries, and also to the Fallopian tubes, to the round ligament, and to the upper part of the uterus, communicating with the uterine arteries by numerous anastomoses.

In the male on the contrary it leaves the abdomen through the inguinal ring, forms with its corresponding vein and the lower part of the vas deferens the spermatic cord, gives branches to the common membrane of the cord and testicle, and is distributed principally in the latter organ.

In its course it gives upward branches to the duodenum, the liver, the transverse meso-colon, the renal capsules, the lymphatic glands in the lumbar region, and to the ureter, and frequently anastomoses with the branches of the mesenteric and lumbar arteries.

III. POSTERIOR BRANCHES. LUMBAR ARTERIES.

§ 1467. The *lumbar* arteries (*A. lumbales*) are the posterior rather than the lateral branches of the abdominal aorta, since they usually arise nearer the centre of the posterior face than the sides of this artery. In this respect there are different degrees between the entire lateral insertion of these arteries and the origin of those which correspond on the right and on the left by a median trunk often several lines in length, before dividing into the right and left lumbar arteries.* All the lumbar arteries of the same subject are arranged in this respect after the same type.

These arteries correspond to the intercostal arteries and are also formed on the same level as they, both generally and particularly. But they are usually larger. Soon after arising, they go outward in the groove of the vertebræ, between the fasciculi of the psoas magnus muscle, to which they give numerous branches, as also to the quadratus lumborum and lumbar vertebræ, gradually arrive at the transverse processes of the latter, and always divide at their base, opposite the intervertebral foramina, into a posterior or dorsal and an anterior or lumbar branch.

* Sœmmerring (p. 277), who follows Murray (p. 75) in this, does not mention that the right and left lumbar arteries arise by a common trunk, but speaks only of the fourth. Others, as Mayer, Boyer, Sabatier, Hildebrandt, and Monro, do not speak of it at all. Portal is more correct when he states in a general manner that the synonymous lumbar arteries of the two sides sometimes arise by a common trunk. We have found that this anomaly is not unfrequent, and that, as we have already remarked, it usually affects all the lumbar arteries. Its frequency, compared with the proportional rarity of a similar arrangement in the intercostal arteries, is worthy of remark, as it coincides with the less marked development of the abdominal parietes.

The *posterior* or *dorsal branch* (*R. dorsalis*) is usually the smaller, and gives off a branch called the *spinal lumbar* artery (*A. spinalis lumbalis*), which passes into the spinal canal through the intervertebral foramen, is distributed on the dura-mater and the pia-mater, descends to the cauda equina, anastomoses with the synonymous branch of the opposite side and also with the anterior spinal artery, and is distributed also to the lower part of the muscles of the back.

The *anterior* or *lumbar branch* (*R. lumbaris*) goes forward between the broad abdominal muscles, within which it anastomoses with the branches of the epigastric artery.

There are usually as many lumbar arteries as there are lumbar vertebræ, viz. five. In general, however, there are not five which arise by separate trunks, but many of them, especially the two or three lower ones, often arise by a common trunk, which soon bifurcates. Sometimes this union of the two lumbar arteries on the same side, situated one above the other, coincides with that of the synonymous branches on the right and left, on one or on both sides, which we have already mentioned.

Most generally even only the four superior lumbar arteries arise from the aorta, and the fifth is given off by the anterior branch of the fourth.

Thus we usually observe at most but four aortic lumbar arteries.*

Finally, there is no symmetry in this respect between the lumbar arteries of the two sides of the body.

§ 1468. The *first lumbar* artery is frequently deficient, and in most subjects it arises from a trunk in common with the last intercostal artery, or it is replaced by the branches of the latter. It is always small, so that when this arrangement exists, and while at the same time the inferior lumbar artery arises by a secondary branch, which is much more common, we observe only three of these arteries.

Even when it is separated from the last intercostal artery, it proceeds a short distance below the lower edge of the last rib, under the insertion of the diaphragm. Sometimes its anterior branch curves between the transversalis abdominis muscle and the peritoneum along which it descends.

The *second lumbar* artery usually arises between the second and the third lumbar vertebræ; it goes first a little from below upward, then from before backward, and from within outward in the groove of the second vertebra. Its anterior branch is distributed principally in the quadratus lumborum and transversalis abdominis muscle.

The *third lumbar* artery arises between the third and fourth lumbar vertebræ, and descends on the first of these two bones. Its anterior

* This assertion cannot be disputed, when we speak of the trunks which arise directly from the aorta. Boyer (p. 127) and Portal (p. 290) have adopted it. But it is very incorrect to consider, with Haller and Sabatier, the inferior intercostal as the first lumbar artery, and consequently to admit six lumbar arteries, although the first lumbar not unfrequently arises from the last intercostal artery, or is replaced by its branches.

branch is very large and passes between the psoas magnus and the quadratus lumborum muscles, to which it gives branches, descends towards the anterior part of the crest of the ilium, and directly above this place goes through the abdominal muscles to the glutæi, where it ramifies and anastomoses with the gluteal artery.

The fourth *lumbar* artery arises on the fourth lumbar vertebra, or between the fourth and the fifth. Its anterior branch passes before the quadratus lumborum muscle, proceeds forward on the crest of the ilium, through the muscles of the back, to enter, like the preceding, into the glutæi muscles.

The fifth *lumbar* artery is a branch of the sacral artery; we shall therefore describe it when speaking of the latter.

CHAPTER V.

ARTERIES OF THE PELVIS AND THE LOWER EXTREMITIES.

§ 1469. The aorta usually divides on the fourth lumbar vertebra, or between the fourth and fifth, into two or three trunks. Two are much larger and more constant, and are the *arteries of the lower extremities* (*A. crurales*, Barclay), being called at their origin the *primitive iliac* arteries; they separate from each other at an acute angle and go outward. The third trunk is much smaller and inconstant, and is called the *middle sacral* artery.

I. MIDDLE SACRAL ARTERY.

§ 1470. The *middle sacral* artery (*A. sacra*, s. *sacralis media*), although very small, being no larger than a lumbar artery, is very remarkable, first, because from its situation and distribution it in fact represents the continuation and the end of the trunk of the aorta; secondly, because it adds to the analogy already existing between the distribution of the upper end and that of the lower part of the aorta.

When it arises from the aorta, it comes from its posterior side, directly above the origin of the two primitive iliac arteries. It is not unfrequently given off by the latter, especially that of the left side, from which it generally then arises very high, directly below its origin.

It descends more or less exactly on the centre of the anterior face of the body of the last lumbar vertebra, and of those of all the false vertebræ of the sacrum and coccyx, directly upon the surface of these bones, and curves frequently.

It gives off only lateral branches.

The first and largest is usually the *fifth* or the *last left lumbar* artery (§ 1469), which is sometimes larger than the continuation of the trunk, and then the middle sacral artery seems to arise from the inferior lumbar artery.

This branch, like all the lumbar arteries, goes backward and outward. It divides, before the intervertebral foramen, between the fifth lumbar vertebra, and the first false vertebra of the sacrum, into two branches, a *posterior* or *dorsal*, and an *anterior*, which is much larger. The first is distributed as usual; it goes outward, under the psoas magnus muscle, and sometimes, when the fourth lumbar artery does not descend so low as usual, it proceeds on the crest of the ilium, and goes to the quadratus lumborum muscle, through which it passes into the broad abdominal, and also into the glutæti muscles; sometimes when these branches arise from the fourth lumbar artery, and the ilio lumbar artery is not as much developed, it penetrates into the psoas magnus and the iliacus muscles.

Two transverse branches more or less tortuous than usually arise from the lateral parts of the middle sacral artery on each false vertebra of the sacrum; these go outward, give numerous ramifications to the periosteum and to the substance of the sacrum, anastomose with the branches of the lateral sacral arteries which go to meet them, penetrate with them into the spinal canal, through the anterior sacral foramina, then emerge from the posterior sacral foramina, and are expanded in the inferior part of the multifidus spinæ muscle.

The middle sacral artery finally terminates at the end of the coccyx, in the lower extremity of the rectum and in the fat which surrounds this intestine.

This artery is not always single; it sometimes divides into two branches, which anastomose with each other and with the lateral sacral arteries.

There is constantly an inverse relation between the middle and the lateral sacral arteries in respect to their development, when one or the other is unusually large.

II. PRIMITIVE ILIAC ARTERIES.

§ 1471. The *primitive iliac* arteries (*A. iliacæ primitivæ*, s. *communes*, s. *pelvi-crurales*, s. *crurales lumbales*, s. *cruri-lumbares*) separate at an acute angle, go outward, downward, and forward, on the last two lumbar vertebræ, and on the first false vertebra of the sacrum, the right after passing on the left primitive iliac vein, the left proceeding directly before and at the same time on the outside of the synonymous vein, and divide, as high as the sacro-iliac symphyses, into two considerable trunks, the *hypogastric* and the *external iliac* artery.

The primitive iliac arteries usually have about the same length and caliber on both sides. The right, however, is most generally a little higher than the left, because the aorta occupies the left side of the vertebral column as the primitive iliac arteries, nevertheless, both arise at the same height. The left descends a little more vertically than the right. Those authors who mention some difference between

the two primitive iliac arteries, especially Mayer, and after him Sœmmerring, indicate only this relation, which in fact is most frequently observed. These anatomists also assert that the right primitive iliac artery is a little smaller than the left.

We have never observed this last difference, but rather the contrary. The first in fact generally occurs, although we have sometimes but very rarely remarked an inverse arrangement, and even in a much more evident manner, although the aorta ascend as usual on the left of the vertebral column.

In one case of this kind now before us the right primitive iliac artery is nearly a third shorter than the left, and bifurcates between the fourth and fifth lumbar vertebræ.

The most usual arrangement is remarkable, because it adds still more to the analogy between the upper and lower halves of the body, since the greater length of the right primitive iliac artery resembles the innominata of the right side, and that of the left side the origins of the left carotid and subclavian arteries by two distinct trunks. The latter arrangement however is only indicated at the lower extremity of the aorta, where a perfect repetition has not yet been found, at least to our knowledge.

The rarest arrangement corresponds to the inversion of the right and left trunks of the arch of the aorta, which has been sometimes observed, although the aorta presented no other anomalies.

The primitive iliac arteries usually give off in their course small branches, which go to the psoas and the iliacus muscles, the ureters, the vena-cava, and the lymphatic glands of this region. They rarely give off a part or the whole of the ileo-lumbar artery, and still more rarely they supply a renal or a spermatic artery.

ARTICLE FIRST.

I. HYPOGASTRIC ARTERY.

§ 1472. The *hypogastric* artery (*A. hypogastrica*, s. *iliaca interna*, s. *posterior pelvica*, s. *hypoiliaca*) descends a little forward and inward, soon penetrates, almost vertically, into the cavity of the pelvis, where it always divides, near its origin, into several branches, which vary in size, and are not always arranged exactly in the same manner, and do not arise from it constantly. It thus distributes the blood to all the parts within the pelvis, to its parietes, and to the muscles which surround it. It is always more or less evidently divided into two branches, a *posterior* and an *anterior*.

§ 1473. The posterior branch gives constantly the *gluteal*, the *leo-lumbar*, the *lateral sacral* and the *obturator* arteries. From the anterior arise the *ischiatic*, the *umbilical* and the *internal pudic* arte-

ries, which usually give off the *middle hemorrhoidal*, the *uterine*, the *vaginal*, and the *vesical* arteries. Frequently however the secondary branches, particularly those of the posterior branch, arise from the trunk of the hypogastric artery, or from the anterior branch; the first is true, particularly of the ileo-lumbar, and the second of the obturator artery; the two latter not unfrequently do not arise from the hypogastric artery but very far from the usual place, either from the primitive iliac or from the crual artery.

I. ILEO-LUMBAR ARTERY.

§ 1474. The *ileo-lumbar* artery (*A. ileo-lumbalis*) is usually the first which arises from the posterior branch of the hypogastric artery, and is frequently divided into several, sometimes into three or four, trunks, which come from different points. Not unfrequently it partially or wholly arises from the primitive iliac, from the trunk of the hypogastric artery, from the anterior branch of the latter, or from the crural artery, or, as happens particularly on the left side, from the middle sacral artery, or, finally, it forms a common trunk with the last lumbar artery. Its volume is by no means always the same.

It goes almost horizontally outward and backward, and soon divides, usually near the sacro-iliac symphysis, into an ascending and a descending branch.

The *ascending* branch ascends between the psoas and iliacus muscles, to which it sends ramifications, anastomoses with the inferior lumbar artery, which it sometimes entirely replaces, or which in other cases takes its place, and either alone or with the latter, sends branches into the spinal canal through the last intervertebral foramen of the lumbar region.

The *inferior* branch is more or less transverse, although a little oblique from above downward; it goes outward, and divides into superficial and deep branches.

The former are distributed on the anterior face of the psoas and iliacus muscles. The others between the latter and the os ilium, enter the muscle through its attached face, and thus penetrate into the substance of the bone through several foramina of nutrition.

All these branches proceed outward and forward, and frequently communicate with those of the circumflex iliac artery.

The anterior branches are distinct, and usually arise from the anterior branch of the hypogastric artery; they are small, and go to the iliacus and psoas muscles. When the ileo-lumbar artery divides into two large branches it often gives off only an ascending and a descending branch; but the superficial portion of the descending branch is frequently a part of the superior, and the anterior is formed only by the deep branches.

II. LATERAL SACRAL ARTERY.

§ 1475. The *lateral sacral* artery (*A. sacra lateralis*) is perhaps more frequently double than single, and is sometimes given off by the trunk of the hypogastric or by the ileo-lumbar artery; in some subjects it is the first artery of the posterior branch of the hypogastric when the preceding artery arises from another point. It is rarely given off by the primitive iliac artery. It goes backward and inward and descends on the anterior face of the sacrum, before the anterior sacral foramina.

In this course it divides into internal and posterior branches.

The *internal* are distributed on the anterior face of the false vertebræ of the sacrum, to which they give their branches, and anastomose with the lateral branches of the middle sacral artery (§ 1470).

The *posterior* or *external* penetrate in the anterior sacral foramina and soon divide into branches, an anterior, distributed on the posterior face of the body, and a posterior, which emerges from the posterior sacral foramen, and is distributed in the lower part of the muscles of the back.

All these branches give twigs to the lumbar and sacral nerves, also to the membranes of the spinal marrow, and anastomose with the anterior spinal artery.

When the lateral sacral artery is double, the upper portion, which goes only backward, is usually separated from the lower; but in this case it does not always come from the trunk of the hypogastric or from the ileo-lumbar artery; it as often arises above the inferior portion, before the posterior branch of the hypogastric artery.

III. OBTURATOR ARTERY.

§ 1476. The *obturator* artery (*A. obturatoria*) is very inconstant in its origin. It usually arises from the posterior branch of the hypogastric artery, whence it comes directly or by a trunk in common with the ileo-lumbar artery, but frequently, at least once in ten times, is given off at another part.

The general character of all these differences in its origin is, that it arises farther outward and forward.

The anomaly is least when the obturator artery arises from the hypogastric artery above and before the place where the latter divides into an anterior and a posterior branch.

Next come the cases where it arises from the anterior branch of the hypogastric artery.

The anomaly is still greater when it arises from the primitive iliac artery. The latter gives it off either within or without the cavity of the pelvis, sometimes directly and sometimes indirectly.

It arises from different parts of the inner and outer portion of the primitive iliac artery.

Sometimes it is given off by the superficial femoral artery, two inches below Poupart's ligament.

When it is not a direct branch of the crural artery, it arises by a trunk in common with the epigastric artery. The most usual case, which is almost as common as that where the artery arises from the hypogastric artery, is, according to our observations, as 16 : 1, in respect to its frequency with that where it arises directly from the crural artery.

The common trunk varies in length from two lines to two inches, but it is usually short and its origin is no higher or lower than usual ; in both cases however its length exceeds the rule.

But in all these anomalies, however remotely the obturator artery may arise from its usual place, it always passes on the horizontal branch of the pubis to enter into the cavity of the pelvis and be distributed as usual, and emerges from this cavity through the obturator foramen. This peculiarity is an important argument in support of the law, that when the organization presents an anomaly it always approximates as much as possible to the normal state.

Between the cases where the obturator artery arises from the hypogastric artery and where it comes from the crural artery, we find an intermediate case, where it arises from the union of two branches nearly equal in size, an anterior and a posterior, which arise, the former from the epigastric or the crural artery, the other from the hypogastric artery, and which anastomose at an acute angle.

It is pleasant to observe that these differences are indicated in the most normal formation, since a smaller or larger anastomosing branch always passes above the horizontal branch of the pubis, extends from the obturator artery given off by the hypogastric artery to the crural or to the epigastric artery. Consequently the internal obturator artery always arises to a certain extent from an anterior and a posterior branch. When the posterior is more developed, the artery seems at first view to come principally from the hypogastric artery, while, when the anterior branch is larger than the other, we are led to conclude that the obturator artery arises from the femoral or from the epigastric artery.*

* These anomalies in the origin of the obturator artery are common, as we have already remarked. Portal, although he asserts that the origin of this vessel is very inconstant, brings forward as proof only the cases where it arises from the trunk or from the branches of the hypogastric artery, but when describing this or the epigastric artery, he mentions those only where it arises from the latter or from the crural artery. Mayer only remarks that the obturator artery is sometimes given off by the crural or by the epigastric artery. Hildebrandt does not mention, when speaking of the obturator or of the epigastric artery, the anomaly which occurs when the first arises from the second, although this is more common than when it arises from the crural artery. He only says that it comes from the hypogastric or from the crural artery, and thus he at least indicates the frequency of the latter arrangement. Monro says that it is sometimes given off by the epigastric artery (p. 353), Sabatier (p. 108) and Boyer (p. 134) remark that it arises in some subjects from the epigastric or from the crural artery.

This arrangement of the obturator artery is not necessarily the same on the right and left side, any more than are the varieties of any other artery. It follows however, from our observations, that it is more common or at least as common to find both sides of the body formed after the same type as to find this type only on one side. Thus in most of the preparations before us, the obturator artery comes on both sides from the hypogastric; in four, it arises by a trunk in common with the epigastric artery, and there are five only in which it arises from the epigastric artery on one side, and on the other, directly from the crural artery by a trunk in common with the epigastric artery.

When the obturator artery arises from the epigastric only on one side, this variety generally occurs on the left. At least our observations have shown that the cases in which it arises from the left epigastric artery are to those where it comes from the right as 10 : 1. We do not think that sex has any influence in this respect; we have not observed that the origin of the obturator artery outward is more common in the female than in the male, as Hesselbach asserts.

§ 1477. Most commonly, when the obturator is a branch of the hypogastric artery, it goes outward and forward, directly below the upper edge of the cavity of the pelvis, gives off in its progress some inconstant ramuscules to the levator ani and obturator internus muscles, to the glands of the pelvis, and to the obturator nerve which accompanies it, passes through the upper and tendinous part of the obturator internus

Murray mentions only those cases where it arises from the epigastric artery. Haller, Sœmmerring, Bichat, Hardrops, Burns, Cooper, and Monro have written the best upon this artery. Haller says (*Ic. fasc.* x. *expl. tab.* 1. *not.* 9): *Non tamen perpetuum est, eam arteriam a pelvi truncis nasci, cum novies viderim ex epigastrica ortam.* Sœmmerring expresses himself with much exactness. This artery, he says, is not constant in its origin: it sometimes arises from the crural and often from the epigasteric artery (p. 294). Bichat also mentions the frequency of this last origin. Wardrop says he has observed it in many subjects. The details on the origin and distribution of this artery given by Burns are most correct; they perfectly agree with our own observations. He says the obturator artery is usually regarded as a branch of the internal iliac artery, but we have as good right to assert that it arises from the trunk or from one of the branches of the external iliac. We have often seen it come from this vessel, an inch above Poupart's ligament. It frequently arises by a trunk in common with the epigastric artery. These details are given in his treatise on diseases of the heart. Farther (*Observations on the structure of the parts contained in crural hernia*; in the *Edinb. Med. and Surg. Journ.*, vol. ii., p. 272) he says that the obturator and the epigastric arteries often arise by a common trunk, perhaps, however, this arrangement may be considered as a rare anomaly, but he has observed it more than twenty times. Cooper (*The anatomy and surgical treatment of crural and umbilical hernia*, 1807, *Edinb Med. and Surg. Journ.*, vol. iv., p. 231) also states, when speaking of the origin of the obturator and epigastric arteries by a common trunk, that it is not rare. Monro (*Anat. of the gullet*, p. 429) establishes the relation between this case and those where it does not exist as 1 : 10. Bekkers also mentions (*Diss. de hernia inguinali*, Paris, 1813) three cases observed by himself, in which these two vessels arose in common from the external iliac artery. We have mentioned these cases, which support our observations, because Hesselbach (*Neueste anatomisch-pathologisch Untersuchungen über den Ursprung und das Fortschreiten der Leisten-und Schenckelbrüche*, Wurzburg, 1815) is wrong on this subject. He maintains, which seems impossible in so distinguished an anatomist, not only that this variety is very rare, but adds, that as to his knowledge the lesion of this artery has been observed only in females, the injury of the obturator artery in the male is not to be feared.

muscle, at the upper part of the obturator foramen, and emerges from the pelvis to be distributed to the upper and internal part of the thigh. It usually gives off also, before leaving the pelvis, a branch, which anastomoses with a corresponding branch of the opposite side on the symphysis pubis, and always gives origin to a branch, which varies in size and anastomoses with the epigastric artery above the horizontal branch of the pubis.

In or directly before the obturator foramen, the obturator artery usually divides into two branches, an *external* and an *internal*.

The *internal* branch is smaller and passes above the obturator externus muscle, gives branches to it and also to the adductor brevis and longus, to the gracilis, to the pectineus, and to the skin of the internal part of the thigh, the scrotum or the labia pudenda, commonly anastomoses with the internal circumflex artery of the thigh, and with the external branch on the circumference of the obturator foramen, and with the external pudic artery in the scrotum and the labia pudenda.

The *external* branch descends deeply outward between the obturator internus and externus muscles, gives branches to these muscles in which it sometimes terminates, is reflected from within outward on the articular capsule and the inner part of the articulation to emerge from the obturator foramen, and passing behind the quadratus femoris muscle goes transversely to the posterior part of the extremity; then it is distributed to the quadratus femoris, to the gastrocnemii, to the adductor longus and brevis, to the upper extremity of the flexors of the leg, finally, to the substance of the external condyle of the femur; anastomoses with the internal branch on the circumference of the obturator foramen and with the ischiatic artery above, and within with the internal circumflex and the internal hemorrhoidal arteries.

§ 1478. The varieties in the origin of the obturator artery are very important to the surgeon. When this artery arises at the usual place from the hypogastric or from the crural artery within the pelvis, and even from the epigastric artery, but far above the crural arch, it is not exposed to be wounded in any of the common operations. But when its origin is situated very low, and it comes either from the crural artery or by a trunk in common with the epigastric artery, as it then always re-enters the pelvis over the branch of the pubis, it is exposed to wounds in the operation for crural hernia.

When the common trunk of this and the epigastric artery is short, it is generally thrown outward toward the ischium in crural hernia, so that it would be divided if the incision should be made in this direction.*

When, on the contrary, this same trunk is long and the obturator artery consequently goes farther inward, it is pushed down by the crural hernia and proceeds before the neck of the tumor inward†.

* See a case of this kind figured in Monro, *Morbid anatomy of the human gut*, Edinburgh, 1811, tab. xiv. fig. 1.

† Wardrop has figured a case of this kind (*Edinb. Med. and Surg. Journ.*, vol. ii. 263,, and points out the means of avoiding the obturator artery in this case. See

We must however in this case determine whether the crural hernia is situated more or less outwardly.

If an external and an internal crural hernia exist on one side, the obturator artery sometimes passes to the inside of the external tumor, even when the common trunk of this vessel and of the epigastric artery is short, and enters the cavity of the pelvis between the two tumors. This has been observed by Burns.

If the obturator artery rises far below the usual place and from the crural artery, either directly or by a trunk in common with the epigastric artery, it generally proceeds deeply, along the pectineus muscle, on the inside of the crural vein, so that, being situated behind the tumor, in case of crural hernia it cannot be wounded in the operation.

But if it was nearer the surface, it might be situated also on the anterior face of the tumor. We have never seen this latter arrangement. Burns and Munro have observed only the first.

IV. GLUTEAL ARTERY.

§ 1479. The *gluteal* or *posterior iliac* artery (*A. glutea*, s. *iliaca posterior*, s. *externa*), the largest artery of the posterior branch of the hypogastric artery, which may be considered as its continuation, arises very often by a trunk in common with the ischiatic artery. Sometimes it furnishes the lateral sacral, the obturator, and all the other arteries which usually come from the posterior branch of the hypogastric artery. It goes downward, forward, and outward, toward the lower part of the ossa ilia, usually sends off, in this course, branches to the iliacus internus muscle, to the obturator internus, to the pyriformis, to the levator ani, and to the os pubis, then emerges from the pelvis through the ischiatic notch, between the pyriformis and the gluteus minimus muscle, is reflected from below upward, penetrates between the gluteus medius and minimus muscles, and divides into numerous branches, which are distributed to the pyriformis and to the three glutei muscles and anastomose above with the epigastric, the last lumbar, and ilio-lumbar arteries, below with the ischiatic and with the external circumflex artery.

§ 1480. The anterior branch of the hypogastric artery gives off, first, the ischiatic artery, the internal pudic, and the umbilical arteries. The vesical, uterine, and vaginal arteries come from one of the latter; sometimes also they arise by a common trunk.

V. ISCHIATIC ARTERY.

§ 1481. The *ischiatic* artery (*A. ischiadica*) arises separate from the internal pudic artery less frequently than by a trunk, which varies in length, in common with the latter, and often by a trunk in com-

Burns, *Observations on the structure of the parts contained in crural hernia*, in the *Edinburgh Med. and Surg. Journ.*, vol. ii. p. 273, fig. 1.

mon with the gluteal artery. It descends before the latter, but at the ischiatic notch it turns backward, continuing still to descend, and emerges from the pelvis, below the pyriformis muscle.

The common trunk of the ischiatic and of the internal pudic arteries frequently does not bifurcate, except in this place, to give origin to two arteries; and from its portion within the pelvic cavity arise branches which are distributed to the pyriformis, to the obturator internus, and to the levator ani muscles.

On emerging from the pelvis the ischiatic artery sends, to the posterior part of the ilio-femoral articulation, branches which anastomose with the circumflex arteries. It afterwards goes backward, toward the gluteus maximus muscle, into which it penetrates from within outward, and within which it is almost entirely distributed.

It often gives off the middle hemorrhoidal, the uterine, the vaginal, and the vesical arteries, especially when it arises by a long trunk, in common with the internal pudic artery.

It not unfrequently gives off an inferior lateral sacral artery when the usual artery of this name does not descend very low, and is unusually small.

It constantly anastomoses by large branches, above, with the ischiatic artery, and with the circumflex arteries below, around the coxo-femoral articulation of the large trochanter.

VI. INTERNAL PUDIC ARTERY.

§ 1482. The *internal pudic* artery (*A. pudenda, interna*, s. *communis*, s. *circumflexa*, s. *pudica pelviena*, s. *hæmorrhoidea externa*) descends into the pelvis, directly before the ischiatic artery, which is generally larger than it, and when it is not given off in this place or even afterward by the latter, emerges with it from the cavity of the pelvis, between the pyriformis muscle and the large sacro-sciatic ligament, between the latter and the small sacro-sciatic ligament, afterward re-enters the pelvis, where it continues to the symphysis pubis, descends along the posterior edge of the descending branch of the ischium, on its internal face, to the tuberosity of the ischium, then reascends, always on the inner side of the bone, along its ascending branch and the descending branch of the pubis, between the obturator internus and the levator ani muscles, and having come above the symphysis pubis, terminates in the external organs of generation.

Thus the pudic artery usually emerges from the pelvis through the sciatic notch, and re-enters it between the two sacro-sciatic ligaments to leave it a second time below the symphysis pubis; but not unfrequently, especially in the male, it always continues in the cavity of the pelvis, and then, proceeding on the lower and lateral portion of the bladder, it goes forward, across the upper part of the prostate gland, where Burns remarks it may be wounded in the operation of lithotomy, particularly when the summit of the prostate gland is cut.

It often gives off within the pelvis one or several vesical arteries, the middle hemorrhoidal, the vaginal, or the uterine, and even the obturator arteries. It also sends smaller branches to the internal parts of the genital and urinary apparatus. In its course along the descending branch of the ischium, besides several small branches which go to the bone, to the obturator internus muscle, to the upper extremity of the flexor muscles of the thigh, to the lower part of the rectum, and to the sphincter ani, it gives off others also, of which the principal are,

1st. A considerable branch which goes outward, between the large trochanter and the ischium, divides into several branches, descends on the neck of the femur and the capsule of the ilio-femoral articulation, between the obturator internus and externus muscles, gives ramuscules to these muscles, and also to the quadratus femoris and to the gemelli muscles, and anastomoses with the circumflex arteries.

2nd. One or more rather large internal branches, which go to the inferior part of the rectum, also to the anus, and form the *external* or *inferior hemorrhoidal* artery (*A. hæmorrhoidea externa*, s. *inferior*).

A little above the tuberosity of the ischium, the interual pudic artery divides into two branches, an internal transverse, and an external anterior ascending branch.

The *internal* branch, the *perineal* artery (*R. internus*, s. *transversus*, s. *superficialis*, *arteria perinæa*, s. *transversa perinæi*) is smaller than the external. It goes inward and a little forward along the transversalis perinei muscle, usually between it and the skin, distributes branches to these parts, and also to the other muscles of the penis, and to the constrictor vaginæ in the female; gives some branches to the lower part of the rectum, and to the sphincter ani, which are termed the *external* or *inferior hemorrhoidal* arteries (*A. hæmorrhoidales inferiores*, s. *externæ*,) and sends others also to the skin of the perineum, labia pudenda, and scrotum.

The *external, anterior, superior*, or deep branch (*R. anterior*, .s *superior*, s. *profundus*, s. *pudendus*) is called the *artery of the penis* (*A. penis*) in the male, and the *artery of the clitoris* (*A. clitoridea*) in the female. When the internal pudic artery gives off considerable branches within the pelvis, this artery not unfrequently arises mostly from the other adjacent branches of the hypogastric artery, especially from the obturator artery, less frequently from the external iliac artery, particularly from an external pudic artery, an anomaly which is indicated in the normal state by the more or less manifest anastomoses between the internal and the external pudic arteries.

This artery is much larger in the male than the female on account of the greater proportional size of the parts, to which it is distributed.

In both sexes it proceeds from below upward around the inner face of the pubis and ischium, between the bone and the corp us cavernosum of the penis and clitoris, and distributes branches to the vagina and prostate gland, the labia pudenda, and the scrotum, finally to the clitoris and the penis, which branches are arranged after the same type.

The branches which go to the prostate gland and the scrotum in the male, to the vagina and to the labia pudenda in the female, are given off the first, directly above the sciatic tuberosity.

After these the trunk descends along the ischium and the pubis, covered by the *erector penis* (*levator penis, clitoris*), and thus comes into the triangular space below the symphysis pubis, where the roots of the corpus cavernosum of the penis in the male, and of the clitoris in the female unite.

In both sexes, the artery then divides into two branches, the superficial and the deep branch.

The *superficial* or the *dorsal* branch, the *dorsal artery of the penis* or *clitoris* (*R. dorsalis*, s. *superficialis penis vel clitoridis*), passes through the suspensory ligament. It is very tortuous when the penis is not erected, and proceeds under the skin at the side of the synonymous artery of the opposite side, with which it sometimes unites, after a very short course, advances thus on the back of the penis, and gives branches to its skin and its fibrous membrane, and sends off others which descend into the scrotum. At the groove behind the glands it forms a crown around it, and finally penetrates into its substance.

The *deep* branch or the *cavernous* artery (*A. profunda*, s. *cavernousa penis*, s. *clitoridis*) passes through the fibrous membrane of the corpus cavernosum of its side, thus penetrates into the substance of this body, and soon divides into several branches. These proceed from behind forward, along the penis, expand in the corpus cavernosum of both the penis and the urethra, and frequently anastomose with those of the opposite side.

The two deep branches often unite in a single common trunk.

Sometimes the internal pudic artery terminates much sooner than we have mentioned, in the transverse perineal artery, and the dorsal artery of the penis or clitoris arises wholly or in great part from the obturator artery.

VII. UMBILICAL ARTERY.

§ 1483. The third artery of the anterior branch of the hypogastric artery, the *umbilical* artery (*A. umbilicalis*), is before birth the continuation not only of the trunk of this artery, or even of the primitive iliac artery, but is larger than the hypogastric and femoral arteries, and is the continuation of the aorta.

At all periods of life the umbilical artery goes a little obliquely forward and inward, toward the upper part of the lateral wall of the bladder, to which it is attached by mucous tissue. Thence it proceeds along this wall, toward the posterior face of the anterior wall of the abdomen, and thus goes from behind forward and from below upward to the umbilicus.

In the fœtus it is open in its whole extent, but soon after birth it is gradually obliterated after leaving the umbilicus, so that finally it

affords a passage to the blood only in the part between its origin and the bladder, the rest of it being changed into a full and solid ligament, enveloped by a fold of the peritoneum, and which may be generally traced to the umbilicus.

During fœtal existence, the lower and anterior part of the umbilical artery which is convex, gives off not only the branches of the hypogastric artery, which we describe above, but also, first, the inferior vesical, then the vaginal, next the uterine, and finally one or more superior vesical arteries, which generally are very distinct from each other. But as it is gradually obliterated, and as at the same time the lower extremities and their vessels are developed, these arteries approach each other, and seem to be in part the upper arteries of the anterior branch of the hypogastric artery.

These branches arise n the following order, which we adopt, since in following it the arteries to be described, correspond from behind forward to those already mentioned.

VIII. VESICAL ARTERIES.

§ 1484. The *vesical* arteries (*A. vesicales*) are distinguished into inferior and superior.

The *inferior* are larger than the superior, and generally there is only one. They arise from the umbilical or from an anterior branch of the hypogastric artery, which is usually the internal pudic, or from the trunk of the hypogastric artery; they go downward and forward to the lower and posterior part, and also to the neck of the bladder, the commencement of the urethra, to the prostate gland and to the vesiculæ seminales in the male, and to the lower part of the vagina in the female.

The *superior* are generally smaller and more numerous; they always arise from the lower part of the umbilical artery, consequently from the most anterior part or from the extremity of the hypogastric artery, and go to the middle and superior part of the bladder.

IX. MIDDLE HEMORRHOIDAL ARTERY.

§ 1485. The *middle hemorrhoidal* artery (*A. hæmorrhoidea media*) often follows the inferior vesical artery from below upward, and from behind forward; but frequently also it arises lower than it, being even sometimes deficient, and is given off by the ischiatic or by the internal pudic artery. Sometimes it arises from the upper or lower hemorrhoidal arteries, with which it always anastomoses, and is distributed on the anterior face of the rectum and also on the posterior part of the bladder, where it communicates with the proper vesical arteries.

X. VAGINAL ARTERIES.

§ 1486. One or two *vaginal* arteries (*A. vaginalis*) usually follow the inferior vesical artery. But this artery is frequently deficient, and it is then replaced by the ramifications of the vesical, the hemorrhoidal, or the uterine arteries. Sometimes also, even when it forms a distinct branch, it does not arise in the order mentioned, but comes from some one of the arteries of the anterior or of the posterior branch of the hypogastric artery.

It goes forward, inward, and downward. Its branches are distributed to the inferior and middle regions of the lateral part of the bladder and of the vagina.

XI. UTERINE ARTERY.

§ 1487. The *uterine* artery (*A. uterina*) generally succeeds the vaginal artery, but it frequently varies from this order. It is however constant.

It goes inward, toward the upper part of the vagina, to which it gives off some branches, as well as to the bladder; it then reascends in the broad ligament along the lateral wall of the uterus. In its course which is very tortuous, it gives off numerous ramifications which are also curved, to the anterior and posterior faces of the uterus. Some of these ramifications are distributed on the surface and others in the substance of this organ.

Its upper part expands by several branches in the folds of the peritoneum; they go to the internal organs of generation, to the Fallopian tubes, and to the ovaries, where they frequently anastomose with the spermatic arteries.

§ 1488. In man, the vessels which correspond to the uterine or the vaginal arteries are small secondary branches of the vesical and of the external hemorrhoidal arteries.

ARTICLE SECOND.

EXTERNAL ILIAC ARTERY.

§ 1489. The *external* or *anterior iliac* artery (*A. iliaca externa*, s. *inferior*, s. *cruralis iliaca*, s. *femoralis*), from its origin, descends from within outward, on the inside of the psoas magnus muscle, sends numerous small branches to this muscle, and also to the lower part of the iliacus muscle.

It usually gives off, at a greater or less distance from the crural arch, two large branches, the epigastric artery, and the circumflex

iliac artery, which are very important in a pathological and surgical point of view on account of inguinal and crural hernias.

The first usually arises a little and sometimes much higher than the second, and even above the crural arch; besides, it always comes from the inside of the iliac artery, while the other constantly arises from its outside.

I. EPIGASTRIC ARTERY.

§ 1490. The *epigastric* artery (*A. epigastrica*) is rarely a branch of the common or deep crural artery,* but it often arises by a trunk, in common with the obturator artery, so that we may consider it as giving off this latter† (1476), although, for all this, its origin is not necessarily displaced and carried higher than usual it is often given off sometimes higher and sometimes lower from the external liliac artery, so that the place where it arises varies to the extent of two inches, although the obturator artery, is not necessarily one of its branches.‡ Thus we may consider erroneous the opinion of Hesselbach, who asserts that this artery varies in its origin and in its course,§ and also that of Mayor,‖ who, like Burns, asserts that it always arises directly below the crural arch. The latter case exists very seldom, for the epigastric artery almost always arises above Poupart's ligament. On the contrary, the place where it detaches itself from the external iliac artery varies much, although it never comes from any other vessel.¶ It however generally arises directly above the crural arch,** and its origin is normal when situated one inch or even two inches above this arch.††

* Monro, *Morbid anatomy of the human gullet*, Edinburgh, 1811, p. 426.

† At least we have never found in this case that the epigastric was a branch of the obturator artery, although we have often seen both arise by a common trunk, and have now several cases of the anomaly before us. Hesselbach, (*Ueber den Ursprung und das Fortschreiten der Leisten-und Schenkelbrüche*, Wurtsburg, p 17) and Bekkers, *loc. cit.*, p. 315), mentions in fact one case where the epigastric arose from the obturator artery. But it is evidently wrong, as it follows from the description of this anomaly given by the former, in saying that the obturator artery came from the inside of the crural more than an inch above the crural arch; since it follows from it we say that the common trunk arose, as is commonly seen in this case, from the external iliac, and not from the internal iliac, or hypogastric artery, as would be the case provided the expressions of Hesselbach were correct. This anomaly however may sometimes occur. Monro (*loc. cit.*, p. 427) seems to have observed it, for he says that in one preparation before him the epigastric arose from the obturator artery, and afterwards went upward and inward, toward the rectus abdominus muscle.

‡ Which Hesselbach seems to think necessary.

§ Hesselbach, *loc. cit.*, p. 17-52.

‖ Mayor, *Beschreibung der Blutgefasse des menschlichen Körpers*, p. 206.

¶ Monro is very correct in saying (*loc. cit.*, p. 254) that the epigastric artery varies much in its origin.

** As has been correctly stated by Bichat (*loc. cit.*, p. 311) and Murray, (*loc. cit.*, p. 89).

†† Outlines, p. 354.

When the epigastric artery arises unusually high it descends near the crural arch, sometimes very low, even below this arch, and always passes behind the commencement of the spermatic cord, above the inguinal ring, so that it is situated on the inside of this cord. There it suddenly curves and reascends vertically on the posterior face of the rectus abdominis muscle, first between this muscle and the peritoneum, then between it and the posterior layer of the sheath.

Soon after it is reflected around the spermatic cord, it gives off, directly above the inguinal ring, a constant branch, which divides into two branches; one goes downward and backward and anastomoses with the iliac artery, the other is transverse and goes inward, proceeds along the horizontal branch of the pubis, behind the inguinal ring, and communicates with that of the opposite side. It also sends to the spermatic cord or to the round ligament of the uterus, some ramifications which penetrate to the scrotum and the labia pudenda, and anastomose below with the spermatic arteries, and above with the uterine arteries in the female. These ramifications, which go to the spermatic cord and to the round ligament of the uterus, sometimes come from the trunk of the external iliac, even above the epigastric artery, when the latter arises lower than usual. This arrangement coincides with the very high origin of the spermatic arteries notwithstanding the sloping situation of the testicles and of the ovaries, since it manifestly depends on the spermatic cord being situated at first higher and more internally.

The trunk of the epigastric artery divides below into two branches, the external, which is generally the larger, and the internal, the smaller; it then ascends on the posterior face and in the substance of the rectus abdominis muscle, sends off several branches outwardly, one of which is frequently larger than the others, in the internal part of the broad abdominal muscles, gives branches to these, the recti, and to the pyramidales muscles, and to the peritoneum, and terminates near the centre of the abdomen, by anastomosing with the branches of the external thoracic, the inferior intercostal, and the internal mammary arteries.

The epigastric artery is situated on the outside of the tumor in internal inguinal hernia, and on the inside in external inguinal hernia; so that in the former case it is wounded when the incision is carried outward and in the latter case when the bistory is directed inward. It is rarely so far distant from the inside that it is raised with the umbilical artery or with the remnant of this vessel, and consequently proceeds on the inside of the tumor, even in an internal inguinal hernia.* In crural hernia it is usually found outward, so that we run the risk of opening it when we cut in this direction. It is however difficult to wound it when it does not arise lower than usual, while this is easy when it comes from the crural artery, in which case it sometimes

* Bekkers, *loc. cit.* p. 316.

ascends on the outside of the inguinal ring, sometimes passes before this opening to go to its inside; it may also be divided, when, although it does not arise lower than usual, it descends first superficially and resumes its situation afterward to go toward the umbilicus.

§ 1491. Sometimes a considerable branch arises from the inside of the iliac artery, below this artery, the following, or finally the crural arch. This is half as large as the epigastric artery, and ascends outside of the inguinal ring, between the external face of the obliquus abdominis muscle and the skin, gives branches to this muscle, particularly to the integuments, extends to the umbilical region, anastomoses below with the epigastric artery, and may be considered as the second epigastric artery. When this branch exists, it is also found on the outside of the tumor in an external inguinal hernia, and it is wounded if the bistory is carried in that direction.

II. CIRCUMFLEX ILIAC ARTERY.

§ 1491. The *circumflex* or *anterior iliac* artery (*A. abdominalis*, s. *circumflexa iliaca externa*, s. *iliaca externa minor*, s. *epigastrica externa*) usually arises on the outside of the iliac artery, opposite the epigastric artery, which is generally a little larger than it. As however it is more constant in its origin than the latter, it is not unfrequently placed more or less below it. It frequently comes from above the epigastric artery, although the latter arises at its usual place. In some subjects it even arises from the crural artery, directly below the crural arch, but always at least from its outside. It goes directly outward and upward toward the iliac crest, frequently sends branches to the tensor fasciæ latæ and sartorius muscles, always gives them to the iliacus muscle, and following the direction of the crest of the ilium, proceeds from before backward and from within outward, in the lower and middle part of the broad abdominal muscles between which its principal branches penetrate. The latter anastomose with the ileolumbar and epigastric arteries. Others, which go outward, toward the great trochanter and the sartorius muscle which they accompany, communicate with the ramifications of the crural artery.

This artery is not unfrequently divided into two trunks, one of which generally arises a little below the epigastric artery.

The external branch is generally much larger than the other, but sometimes becomes a small branch, while the principal branches of the artery go obliquely inward and upward. In this case, when one or more of these branches are considerably large, the operation of paracentesis might give rise to a formidable hemorrhage.*

* Ramsay, *Account of some uncommon muscles and vessels* in the *Edinb. med. and surg. journ.*, vol. viii. p. 282, tab. 1, fig. 1.

ARTICLE THIRD.

CRURAL ARTERY.

§ 1493. The external iliac artery after emerging from the crural arch, under the centre of which it passes, is called the *crural* or *femoral* artery (*A. cruralis*, s. *femoralis communis*, s. *cruralis inguinalis*, s. *cruri-inguinalis*). It is situated in this place on the neck of the femur, almost directly below the skin, covered only by the fascia lata aponeurosis, the fat, and the lymphatic glands of this region over the vein which accompanies it, and occupies nearly the centre of the space between the symphysis pubis and the anterior and superior spine of the ilium, between the adductor muscles of the thigh on one side, the rectus anticus and the sartorius muscles on the other.

Beside the small inconstant ramifications which it distributes to the skin, to the muscles, and to the lymphatic glands of this region, it gives off, sometimes higher and sometimes lower from its inside, one, two, and even three *external pudic*, *scrotal*, or *vulvar* arteries, the upper, the lower, and the lowest (*A. pudendæ externæ superior*, *inferior et infima*, s. *tertia*).

These arteries which proceed directly under the skin, go from without inward in the integuments and the fat of the pubis and of the lower part of the abdomen, the inguinal glands, the scrotum, and the labia pudenda, where they form the *anterior scrotal* and *labial* arteries (*A. Scrotales et labiales anteriores*). To this is referred the second epigastric artery mentioned above.

§ 1494. The crural artery has not always the same extent. Its length is principally determined by the origin of the deep femoral artery, which always arises from its posterior and inner side, so as to be covered by it. This branch is generally given off from the trunk one or two inches below the crural arch, rarely higher,* but sometimes also it arises directly below the arch or even, which is always very rare, above it. On these differences depend also those in the size of the superficial and deep crural arteries or of the continuation of the trunk. When the crural artery arises very high it is usually much larger than common, nearly equal to the superficial in size, and then it frequently gives off the upper branches of the latter, particularly the external pudic arteries, but more frequently still the circumflex arteries, which we shall mention directly. Sometimes the latter, and the deep crural artery arise from a common trunk and at the same place.

* Burns has already corrected the error made by Bell, who asserted that this division usually occurred four inches above the crural arch.

I. DEEP CRURAL ARTERY.

§ 1495. The *deep crural* artery (*A. cruralis*, s. *femoralis profunda*) gives off frequently, not far from its origin, two branches called the *circumflex arteries of the thigh* (*A. circumflexæ femoris*), which are distinguished into external and internal. This however is not always the case. Sometimes, but very rarely, these two arteries (more frequently one of them, particularly the internal, and very rarely the external) arise from the common crural or even from the superficial crural artery, below the origin of the deep femoral artery.

I. CIRCUMFLEX ARTERIES.

§ 1496. The *internal circumflex* artery (*A. circumflexa femoris interna*) generally arises higher than the external. Its origin is sometimes two or three inches above that of the latter; hence it comes more frequently than the other from the common crural artery, directly below the crural arch and the epigastric artery higher even than the three external pudic arteries, and it is thus sometimes given off by the external iliac artery. It generally comes from the inside, but in some subjects from the outside of the common crural artery. In this case it gives one or more branches, which go outward and upward, into the inguinal glands, the iliacus and the sartorius muscles, and anastomose with those which arise from the crural artery. The trunk goes inward, passing in the second case below the crural artery, and at the same time descending a little when not unusually high. It gives branches to the lower part of the psoas iliacus, the pectineus, to the short and long adductor muscles, afterward goes deeply inward and backward, below the pectineus muscle, and immediately around the neck of the femur, and divides behind the pectineus into two branches, a superior or anterior and an inferior or posterior.

The *superior* is smaller and soon subdivides into two branches; the *external* and *smaller* is called the *artery of the cotyloid cavity* (*A. acetabuli*); it goes to the capsular ligament and to all parts of the articulation, turns on the head of the femur, anastomoses by a large ramuscule with the obturator artery, and distributes branches to the obturator externus muscle. The *internal* is larger, passes behind the adductor longus and brevis, and is expanded in the upper part of the adductor magnus muscle.

The *inferior* branch is much larger than the preceding, and is the continuation of the trunk. It descends backward, behind the adductor magnus muscle, is distributed principally to the gracilis muscle, the three long flexors of the leg, the long head of the biceps femoris, the semimembranosus and the semitendinosus, and finally becoming sometimes one, sometimes two branches, called the *trochanterian*, which are distinguished into an *upper* and *lower* (*R. trochantericus superior et*

inferior), it is reflected from before backward, on the inner part of the femur, then outward and upward, to arrive at the great trochanter, ascends before the gemelli and quadratus femoris muscles, between themand the obturator externus muscle, gives branches to these muscles, and also to the tendon of the obturator internus and piriformis, and anastomoses with the external circumflex, the gluteal, the ischiatic the inferior hemorrhoidal, and the obturator arteries. This inferior branch is sometimes smaller, and is distributed only to a portion of the adductor magnus and to the gracilis muscles; all the other ramifications, especially the anastomotic, arising from the superior.

Beside the anastomoses between the external and the internal circumflex arteries at the posterior part of the thigh, these two arteries often unite by a very large transverse branch on the anterior face of the bone, which, added to their communication with the crural artery, completes the circle of anastomosis.

By all these anastomoses the internal circumflex artery is the principal channel through which the blood comes to the lower extremity when the external iliac artery is tied. It is consequently one of those vessels which are considerably dilated after this operation.*

§ 1497. The *external circumflex* artery (*A. circumflexa femoris externa*) arises still more frequently than the preceding, although not always from the outside of the deep crural artery. It comes sometimes from the place where this latter is given off from the common femoral artery, and sometimes much lower.

It goes obliquely outward, turning on the anterior face of the femur, directly on the upper part of the cruræus muscle, gives small branches to the lower extremity of the iliacus muscle, and soon divides into an *ascending* and a *descending* branch.

The *descending* branch which arises sometimes wholly, sometimes partially, from the superficial or from the deep femoral artery, gives ramuscules to almost all the outer part of the triceps extensor, also to a small portion of the rectus femoris muscle, and sends upward, across this muscle, a transverse vessel which goes to the large trochanter, penetrates into its substance, and forms a net-work on its surface by anastomosing with the ramifications of the internal circumflex artery.

The *ascending* branch penetrates from before backward and from within outward, principally into the gluteus medius muscle, passes above the great trochanter, and anastomoses in this place with the external circumflex, the gluteal, and the ischiatic arteries.

These anastomoses are also very much dilated when the external iliac artery is tied.

II. PERFORATING ARTERIES.

§ 1498. The deep femoral artery after giving off the circumflex arteries goes backward, inward, and downward, so that it descends

* A. Cooper, *Account of the anastomoses of the arteries of the groin*; *Med. Chir. Trans.*, vol. iv. p. 424.

on the inside of the femur, between the vastus internus externally, the adductor longus and brevis internally, and the superficial femoral artery forward. In this course it generally gives off some anterior and several posterior branches; the latter are larger and more constant.

The *anterior* generally arise very high from the outer and inner sides of the artery. Sometimes there is only one and sometimes we find several on each side. The *external* goes to the vastus internus and penetrate also to the crurales muscle. The *internal* go to the adductor magnus and adductor brevis muscles, and, passing between these two muscles, arrive at the upper and middle part of the gracilis internus muscle, of which they are the principal nutritious vessels.

Properly speaking, the trunk of the deep femoral artery divides to give rise to the posterior branches, since it penetrates much farther back, to the posterior part of the thigh behind the femur.

These branches have been termed the *perforating* arteries (*A. femoris perforantes*), because they pass through the adductor magnus muscle to the parts behind it.

They vary in number from one to five; for sometimes the whole trunk, or at least that part from which the perforating arteries generally arise, goes backward, after passing through the summit of the adductor magnus muscle, and then descends behind this muscle, while in other cases it proceeds before it, and gradually gives off branches, which pass thorugh it to arrive at the posterior part of the thigh. This difference is sometimes observed in the two lower extremities of the same subject.

The *superior* or *first perforating* artery commonly divides into two branches, an upper which ascends, and a lower which descends.

The *superior* branch ascends toward and around the great trochanter, on which it anastomoses with the ramifications of the external circumflex artery, and penetrates into the lower part of the gluteus maximus muscle, where it communicates with the gluteal artery.

The *inferior* branch turns around the femur forward and outward; it is distributed to the vastus externus and to the rectus, and to the long head of the biceps muscles. It also gives off the *nutritious artery of the femur* (*A. nutritia ossis femoris*).

The *second and third perforating* arteries sometimes arise opposite each other, one from the outside the other from the inside of the femoral artery. The external goes to the triceps extensor muscle, the internal is distributed to the biceps, the semitendinosus, and the semimembranosus muscles.

Sometimes we find also two other perforating arteries, an external and an internal, which are distributed in the same manner.

In some subjects the upper branch, then unusually large, is the only one which passes through the adductor magnus muscle. It divides into two branches, an ascending which gives all the internal ramifications to the flexor muscles; the inferior is larger, and gives off all the external ramifications except the first. The latter is not

visible externally, but directly where the adductor magnus muscle is inserted it passes through this muscle to empty itself from within outward, in the vastus externus and the rectus femoris muscles.

The sciatic nerve also receives considerable branches from the perforating arteries.

A large branch, the anterior extremity of the trunk of the deep femoral artery, always descends before the adductor magnus muscle, between it the adductor longus and brevis muscles distribute branches to these muscles, and near the centre of the thigh give off the inferior nutritious artery of this bone.

Many of these branches, especially the lower, sometimes arise from the superficial, and not from the deep femoral artery. They all anastomose with each other. Farther, the superior, as we have already observed, communicate with the external femoral and the gluteal arteries. The lower and the middle are connected by large anastomosing branches with recurrent branches, which arise from the lower part of the superficial femoral and the popliteal arteries.

Thus when the common or superficial artery is obliterated to a greater or less extent, the perforating branches of the deep femoral artery, and generally all its ramifications, are very much dilated, larger even than the trunk, as is proved by the observations of Deschamps,* Dupuytren,† and Astley Cooper.‡

The deep femoral artery supplies the blood to most of the muscles of the thigh, to almost all the skin of this extremity, and to its bone; it also gives origin to the accessory vessels for the circulation of the blood in the lower extremity.

II. SUPERFICIAL FEMORAL ARTERY.

§ 1499. The *superficial femoral* artery (*A. femoralis superficialis*, s. *cruralis femoralis*, s. *cruri-femoralis*, s. *femoro-tibialis*), after the origin of the deep, penetrates a little farther between the vastus internus on one side and the adductor longus and brevis on the other, passes below the sartorius to arrive at the inner side of the thigh, proceeds before the adductor muscles to the commencement of the lower fourth of the thigh, enters in this place the tendon of the adductor magnus muscle, and thus comes on the posterior face of the limb, where it is called the popliteal artery.

In its course it gives off branches, of which the principal are the internal and the external; but it also sends off anterior and particularly posterior branches, especially at its lower part.

The internal branches are distributed in the adductor, the gracilis, and the sartorius muscles.

* *Observ. anat. faites sur un sujet opéré suivant le procédé de Hunter, d'un anévrysme de l'art. re poplitée*; in the *Mém. prés. à l'Instit.*, 1805, vol. i. p. 251.

† *Journ. de Corvisart*, vol. vii. p. 536.

‡ *Dissection of a limb, on which the operation for popliteal aneurism had been performed*, in the *Med. chir. trans.*, vol. ii. p. 250.

The external are distributed in the latter to the rectus, and particularly to the vastus internus; the deep pass behind the femur, and go to the vastus externus.

The anterior distribute blood to the sartorius muscle and to the skin, to which also go some ramifications of the other branches.

The posterior go to the vastus internus, but particularly to the lower part of all the flexors of the leg, and as they turn around the femur, they also penetrate into the vastus externus and extend to the skin. They anastomose by large branches above with the perforating arteries, below with the superior and inferior articular arteries.

The superficial femoral artery deserves its name, because, during its whole course, it is situated near the skin. It is covered for a short distance by the sartorius muscle which crosses it. We may then easily find it in operations. The place where it is exposed in Hunter's operation for aneurism is directly below the lower edge of the sartorius muscle at the inner part of the anterior side of the thigh.* The objection that when we operate in this place the articular arteries are lost and the circulation cannot continue is unfounded,† since when the superficial femoral artery is entirely obliterated, the anastomoses of the branches of the deep femoral artery with the lower branches of the superficial, and with those of the popliteal artery, supply channels which are large even in the normal state, and through which the blood may pass from the branches of the deep femoral into the articular arteries, and into all the parts below the ligature.

III. POPLITEAL ARTERY.

§ 1500. The *popliteal* artery (*A. poplitæa*, s. *cruri-poplitæa*, s. *femoro-poplitæa*) is the lowest portion of the femoral artery, and descends into the calf of the leg, inclining a little from within outward; it extends from the beginning of the lower fourth of the femur to the summit of the upper fifth of the leg. Sometimes it is much longer, because the superficial femoral artery penetrates the adductor magnus higher, and also divides a little higher.

It is separated at its upper part from the femur, and from the posterior face of the capsular ligament of the femoro-tibial articulation at its central part, by an abundance of fat and cellular tissue. The tibialis posticus muscle separates it below from the tibia.

Behind, it is separated at its upper part from the skin by the sciatic nerve and the popliteal vein, by fat and by mucous tissue; in its lower part, by the muscles of the calf of the leg, and the plantaris muscle.

Above, it is separated by abundance of fat and cellular tissue, outward from the biceps femoris muscle, and inward from the semitendi-

* Home, *An account of Hunter's method of performing the operation for the cure of popliteal aneurism*, in the *Trans. of anass. for the improv. of med. and surg. knowl.*, vol. i. no. 4. *Additional cases, &c.* ibid. vol. ii. no. 19.

† Deschamps, *loc. cit.*, vol. i. p. 254.

nosus and the semimembranosus muscles. The two upper heads of the triceps extensor muscle closely envelop it at its lower part. It is then looser and also nearer the bone above and below, but is every where surrounded with an abundance of fat and cellular tissue. This circumstance, added to the prominence of the flexor muscles of the tibia and of the fibula, renders it difficult to fix it and to compress it.

§ 1501. Beside certain inconstant branches which, when it passes through the tendon of the adductor magnus muscle higher than usual, appear near its origin, on the posterior face of the thigh, it gives off,

1st. From its upper part or crural portion, particularly from the posterior and inner side of this portion, several branches, which go to the lower part of the flexor muscles of the tibia.

2nd. Lower down *three superior articular* arteries (*A.* s. *rami articulares superiores*), which are distinguished into internal, external, and middle, which sometimes, even usually, all, or at least two, arise by a common trunk from the anterior side of the popliteal artery. Some of these arteries are double in some subjects, then only one is detached from the trunk before the other, and the superior anastomoses with the muscular branches mentioned before. The interna and external are usually larger than the middle.

§ 1502. The *external superior articular* artery (*A. articularis genu superior externa*) rests directly on the tibia, and passes between this bone and the common tendon of the biceps muscle, usually goes from below upward, but always from behind forward and from within outward, and gives off, in its course, ramifications to the inferior belly of the biceps muscle, also to the lower part of the vastus externus, is distributed on the outer condyle of the femur, penetrates into the articular capsule, gives branches to all the ligaments of the knee, and communicates by a very large anastomosing branch which proceeds across to the anterior face of the femoro-tibial articulation, on the common tendon of the extensors of the thigh, on one hand, both on the side and forward with the ascending branches of the external inferior articular artery on the other, on the median line and forward, with a similar branch of the internal superior articular artery.

§ 1503. The *internal superior articular* artery (*A. articularis genu superior interna*) varies more than the external and the middle in respect to its origin, for it not only forms a distinct trunk much more frequently than the latter, but it also not unfrequenly, in fact almost normally, arises very high, as it sometimes comes from the superficial femoral artery, and then descends along the inner edge of the vastus internus muscle, to which it distributes ramifications. In this case, we find at the most normal place of its origin a small artery, which is sometimes a branch of a common trunk of the articular arteries, and sometimes arises directly from the popliteal artery, and anastomoses with the superior internal articular artery. When the origin of the latter is placed low, it goes a little from above downward, like the external, before it proceeds inward and forward. It divides into

one or several muscular branches, which go to the lower part of the vastus internus muscle; another median artery is situated lower, and passes behind this muscle and the common tendon of the extensors of the thigh, goes into the inner condyle of the femur and to the inner part of the ligaments of the knee; finally, a third, which is superficial; this proceeds on the anterior face of the femoro-tibial articulation, directly under the skin, anastomoses below with the branches of the internal inferior articular artery, and outwardly and transversely with the transverse branch of the external superior articular artery.

Both the external and the internal superior articular arteries give off considerable and recurrent branches, which communicate with the branches of the deep and superficial femoral arteries.

§ 1504. The *middle articular* artery (*A. articularis genu media azygos*) very rarely forms a distinct trunk, and is generally given off by the external superior articular artery. It goes forward and downward, penetrates from behind forward between the two condyles of the femur, and is distributed near the centre of the knee, in the femoro-tibial articulation, to the crucial ligaments, to the articular fat, to the posterior and middle part of the capsular ligament, and anastomoses with the branches of the inferior and also of the other two superior articular arteries.

§ 1505. Some small external and internal ramifications arise from the middle and inferior part of the popliteal artery and of its crural portion; these are not constant and go to the lower part of the flexor muscles of the tibia and fibula. This portion then gives off the arteries of the gastrocnemii muscles and the interior articular arteries.

§ 1506. The *arteries of the gastrocnemii muscles* (*A. gemellæ*) usually arise, at least in part, above the inferior articular arteries, and come from the posterior side of the popliteal artery. They are generally two, an external and an internal, one for each of the two upper heads of the triceps suræ muscle. They rarely arise opposite each other. We frequently find also several other smaller gemellæ arteries, which however do not always exist. These vessels furnish the blood to the plantaris muscle, which however sometimes receives a proper and distinct branch.

§ 1507. The *inferior articular* arteries (*A. articulares genu inferiores externa et interna*) are usually two, an *external* and an *internal*, which generally form two distinct trunks. They arise from the anterior and lateral side of the popliteal artery, rarely at the same height. Sometimes one and sometimes the other is higher. Generally they are of the same size.

§ 1508. The *external* sends branches to the lower and middle head of the triceps suræ muscle. These branches however sometimes arise, at least in part, from a special branch of the popliteal artery. The artery then, passing directly above the external head of the tibia, below the external lateral ligament of the knee, and on the capsular ligament of the articulation, goes thus from behind forward. In its course it

gives branches to the articular capsule, and anastomoses on one side by ascending lateral branches with the descending branches of the external superior articular artery, on the other by a large transverse branch, which passes above the lower part of the anterior face of the tendon of the extensors of the thigh, below the patella, with a similar transverse branch from the internal inferior articular artery.

§ 1509. The *internal* usually proceeds a little downward, goes from behind forward, and from without inward, below the internal head of the triceps suræ muscle, directly surrounds the inner condyle of the tibia, gives numerous branches to the popliteus muscle, sends downward other branches, which anastomose on the internal face of the tibia with the recurrent branches of the posterior tibial artery, gives also others which are larger and transverse, which communicate directly above the insertion of the common tendon of the extensors of the thigh with the recurrent branches of the anterior tibial artery, and finally goes upward and forward on the external anterior face of the ligament of the patella, where it anastomoses by several ramifications with the internal superior and with the external inferior articular arteries.

§ 1510. Besides these two inferior articular arteries, we sometimes find a *middle articular* artery (*A. articularis inferior media*, s. *azygos*), which however arises oftener from the internal, and which penetrates from behind forward in the femoro-tibial articulation, on the median line, between the two condyles of the tibia.

The popliteal artery generally gives off no other branches than those which have been described ; it is then the principal source of the anastomotic articular branches, by which, from the communication established between the upper and the posterior branches of the deep femoral artery, or between the inferior and recurrent branches of the arteries of the knee, the circulation of the blood may continue regularly in the leg, even when the superficial femoral and the popliteal arteries are obliterated. Thus these vessels are very much dilated after an operation for popliteal aneurism, where the superficial femoral and the popliteal arteries are obliterated.

ARTICLE FOURTH.

ARTERIES OF THE LEG.

§ 1511. The popliteal artery generally, after passing an inch without giving off any branches except those which go from its lower part into the soleus or to the third head of the triceps suræ muscle, divides about an inch below the knee very rarely higher and opposite the articulation, into two branches, called the *tibial* arteries (*A. tibiales*, s. *cremiales*, Barclay). Of these two branches, the posterior is the larger, and may be considered from its direction as the continuation of the trunk, and is the common trunk of the *posterior tibial* and *peroneal*

arteries; the anterior is smaller, separates from the trunk, and is the *anterior tibial* artery. The common posterior trunk is always larger than the anterior; sometimes it exceeds it greatly in size, in which case the latter is arrested in the middle of the leg, and all the branches which it generally gives off then arise from the posterior tibial and from the peroneal artery.

It sometimes divides very high. Thus, in a case observed by Sandifort,* the crural artery divided directly below Poupart's ligament. Portal† has also found it to divide higher than usual. Ramsay‡ has seen it bifurcate, not in fact above the knee, but at least above the popliteus muscle; the anterior tibial artery passed before this muscle, between it and the tibia, and was there compressed by him.

I. ANTERIOR TIBIAL ARTERY.

§ 1512. The *anterior tibial* artery (*A. tibialis antica*, s. *rotularis*)§ describes a slightly acute angle to go forward above the upper edge of the interosseous membrane. On the anterior face of the leg it divides into two branches, the smaller of which is the ascending or recurrent branch; the other is the continuation of the trunk; the latter descends on the anterior face of the limb, and is distributed on the tibial side of the leg and foot.

§ 1513. The *recurrent* artery (*A. recurrens*) gives branches to the tibialis posticus muscle, and is situated directly on the outer face of the upper extremity of the tibia; it proceeds from below upward, to be distributed partly in the head of the tibia, partly also to the external and lower part of the ligaments of the knee and the common tendon of the extensor muscles of the leg. It anastomoses with the inferior articular artery, and by means of it with the superior and likewise with the ramifications of the femoral artery. We must place it among the accessory vessels of the lower extremity.

§ 1514. The trunk of the anterior tibial artery descends on the anterior face of the interosseous membrane, between the peroneus brevis muscle, the extensor digitorum communis longus, and the extensor longus pollicis proprius, and is covered by the two latter. It gives outward and inward numerous short and small branches, some of which are distributed in these muscles, while others pass through them to go into the peronei muscles and even to the skin.

* *Obs. anat. path.*, book iv. p. 97. The crural artery divides there into an anterior and posterior tibial artery, and we cannot admit that there is any doubt in regard to its high division into a superficial and a deep crural artery, since Sandifort expressly says, that on the left side the division occurred as usual in the calf of the leg.

† *Anat. méd.*, vol. iv. p. 230.

‡ *Account of an unusual conformation of some muscles and vessels*; in the *Edin. Med. Journ.*, vol. viii. p. 283.—Barclay, *loc. cit.*, p. 263.

§ We describe this artery first, although from its direction and its small size it is not the continuation of the trunk, because it corresponds to the radial artery in its distribution.

When the posterior tibial or the peroneal artery is unusually large, the anterior tibial artery terminates on the back of the foot or in the leg. Sometimes it does not exist as a separate trunk, and is replaced in the leg by the perforating branches of the posterior tibial artery and on the back of the foot by the peroneal artery. In some subjects also it is obliterated at the articulation of the foot, while above and below this part it admits the blood and is distributed as usual.* It generally furnishes the dorsal arteries of the foot and those of the large toe.

Near the lower end of the leg, it gives off the two *malleolar* arteries (*A. malleolares*), an external and an internal, which vary much in their size and place of origin.

§ 1515. The *external malleolar* artery (*A. malleolaris externa*) often arises a little higher than the internal, then descends from behind forward between the tibia and the fibula, resting directly on these bones and below the tendon of the peronei muscles, goes outward, expands on and in the external malleolus, frequently sends branches also to the anterior part of the lower end of the tibia, gives ramifications to the extensor hallucis brevis and abductor minimi digiti muscles, and anastomoses by a large branch with the recurrent branches of the tarsal artery on the anterior face of the articulation of the foot, and also with the anterior branches of the peroneal artery on the outside of the os calcis. This branch is constant, but it varies in size, and when large it partially or wholly gives off the dorsal artery of the foot. Sometimes it does not arise from the anterior tibial but from the peroneal artery, when the latter is unusaally large. It is rarely given off by the peroneal artery, and arises still less frequently from the posterior tibial artery.

§ 1516. The *internal malleolar* artery (*A. malleolaris interna*) usually arises a little below the preceding. It not unfrequently divides into several branches, which are given off from the anterior tibial artery, one on the tibia and the other on the tibio-tarsal articulation.

It proceeds from without inward, under the tendons of the tibialis anticus and the extensor digitorum longus muscles, resting directly on the tibia and in the second case on the capsular ligament, arrives at the internal malleolus, distributes branches to this eminence, to the capsule of the articulation of the foot, to the astragalus, and anastomoses with the branches of the tarsal and posterior tibial arteries.

When two internal malleolar arteries exist, they communicate with each other.

This artery also sometimes arises, but more rarely than the preceding, from the peroneal or the posterior tibial artery.

§ 1517. After giving off the malleolar arteries, the trunk of the anterior tibial artery passes under the tendons of the extensor digitorum communis longus, on the outside of the extensor hallucis proprius, and comes on the back of the foot, giving off right and left small branches,

* This arrangement does not necessarily arise from the primary formation; it may, as Burns correctly remarks (or Barclay, *loc. cit.*, p. 293), be accidental and be produced by compression. This ought also to be admitted in the second case.

which go into the periosteum, the dorsal ligaments of the tarsus, and the tendons of the extensor and peroneus brevis muscles. In this place it is called the *dorsal artery of the foot* (*A. pedæa*). The latter is rarely the continuation of the trunk of the peroneal or of the posterior tibial artery.

§ 1518. Internal and external branches arise from the dorsal artery of the foot. The latter are more numerous, larger, and more constant than the internal. We observe two particularly, the tarsal and the metatarsal artery.

The *tarsal* artery (*A. tarsea*) arises from the outside of the dorsal artery of the foot, sometimes higher and sometimes lower on the back of the foot, even above the lower extremity of the tibia, in which case the external malleolar artery is very small; this vessel is considerable, and its caliber almost equals that of the continuation of the trunk of the anterior tibial artery; thus it would be more convenient to term it the *external tarsal* artery (*A. tarsea externa*), in opposition to another branch which corresponds to the inside.

This tarsal artery goes transversely outward on the astragalus and os calcis, gives branches to these bones and also to the external part of the ligaments of the tibio-tarsal articulation and to the tarsus, sends off toward the external malleolus a large branch which anastomoses with the external malleolar artery (§ 1515), communicates on the outside of the os calcis with the branches of the peroneal artery, gives off forward other branches which unite to those of the metatarsal artery, penetrates to the cuboid bone, to the posterior extremity of the fifth metatarsal bone, anastomoses also with the external plantar artery on the outer edge of the foot, and distributes branches to the extensor digitorum brevis and to the abductor minimi digiti muscles.

§ 1519. Next comes the *metatarsal* artery (*A. metatarsea*), which also arises from the outside of the dorsal artery of the foot, and varies so much in regard to its origin that it is sometimes a branch of the tarsal artery, and sometimes arises several inches distant from it, and from the dorsal artery of the foot, directly behind the anterior edge of the tarsus.

It is generally smaller than the preceding. Its direction, like that, is from within outward, assuming a course more transverse as it arises farther forward, and is always situated below the extensor digitorum brevis muscle. It is more or less evidently convex forward, and forms an arch, which is completed outwardly by the anastomosis constantly existing between it and the tarsal artery. This arch, on the outer edge of the tarsus, is changed by the smaller but constant branches of the tarsal artery into a vascular net-work, which covers most of the back of the foot. When this artery arises far backward, we usually find a second, which is smaller and proceeds on the anterior edge of the dorsal face of the tarsus, and which communicate with the posterior by very analogous longitudinal branches, which correspond in number and situation to the three external interosseous spaces. This second artery is not so much a branch of the dorsal artery of the foot as the result

of anastomoses between these longitudinal branches and the dorsal interosseous arteries.

Sometimes there are even three metatarsal arteries, a third existing between the two we have mentioned.

A transverse arch, the convexity of which looks forward, constantly forms on the anterior part of the dorsal face of the tarsus or on the posterior part of the metatarsus. This arch contributes more or less but constantly with the posterior perforating arteries given off by the inferior tibial artery to form the *dorsal interosseous* arteries (*A. interosseæ dorsales*).

This vascular net-work is termed the *dorsal arch of the tarsus* (*A. dorsalis tarseus*). It varies much in extent and complexity.

A *dorsal interosseous* artery proceeds in each space between two metatarsal bones. These arteries are always very large and sometimes of an enormous caliber. They are four in number; but the first or the most internal, comprised between the first and second metatarsal bones, is considered as the continuation of the trunk and is called very improperly the *external dorsal artery of the large toe* (*A. hallucis dorsalis.*

All these dorsal interosseous arteries are similar in the following respects:—

1st. They anastomose by their posterior extremity with the posterior perforating arteries.

2nd. They communicate with the anterior perforating arteries by their anterior extremity, between the bases of the first phalanges of the toes.

3rd. They give off, outward and inward, branches, by which they anastomose with each other on the back of the tarsus, and which are distributed in the external interosseous muscles, the bones of the metatarsus, the abductor pollicis longus, and the skin of the dorsal face of the tarsus and of the toes. The branches which go to the toes, each of which receives at least two, the *tibial* and the *peroneal*, are called the *dorsal arteries of the toes* (*A. digitales dorsales tibiales et peroneæ*).

These superior interosseous arteries sometimes divide anteriorly into two branches, the *tibial* and the *peroneal*, each of which always goes to a different toe.

From the outer part of the tarsal arch a branch usually arises, which is also connected with the superior interosseous arteries, but which goes to the abductor minimi digiti muscle, and sometimes arises from the fourth interosseous artery, or, according to the usual way of numbering them, from the third. This last also most generally gives off another branch to the fibular side of the little toe, the dorsal peroneal branch of this appendage, while itself gives off the dorsal tibial branch.

Sometimes but rarely the second superior interosseous artery, generally called the first, does not arise from the metatarsal artery, but from the continuation of the trunk of the dorsal artery of the foot, and then the latter corresponds more than usual to the middle of the dorsal face of the tarsus.

§ 1520. The internal branches of the dorsal artery of the foot are smaller than the external. They are generally as numerous, but usually there is only one very large. That arises about the centre of the tarsus, a little before the anterior extremity of the astragalus. It is well called the *internal tarsal* artery (*A. tarsea interna*).

This artery proceeds obliquely from without inward and from behind forward, distributes branches to the internal half of the bones of the tarsus and also to the first metatarsal bone, to part of the extensor digitorum brevis and of the abductor pollicis pedis, and anastomoses with the dorsal artery of the back of the foot on the dorsal face of the tarsus, with the first interosseous artery, with the internal plantar artery on the inner edge of the foot, finally with the internal malleolar artery, and thus contributes to form the dorsal arch of the tarsus.

§ 1521. The trunk of the dorsal artery of the foot divides, between the posterior extremities of the first and second metatarsal bones, into two branches: one is the continuation of the trunk, the *first metatarsal* artery, usually termed the *dorsal artery of the great toe* (*A. dorsalis hallucis*); the second, the *deep anastomosing branch* (*R. anastomoticus profundus*), passes directly to the sole of the foot, between the two bones, and forms with the external plantar artery the *deep plantar arch* (*A. plantaris profundus*), whence arise most of the *plantar arteries of the toes* (*A. digitales plantares*).

The *dorsal artery of the large toe* usually proceeds from behind forward on the back of the foot, along the external edge of the toe, and there divides into two branches, which become, one the *common dorsal artery of the large toe*, the other the *dorsal tibial branch of the second toe*.

It anastomoses most generally either at its place of origin or by one of its two branches with the plantar artery of the large toe.

II. POSTERIOR TIBIO-PERONEAL ARTERY.

§ 1522. The *common trunk of the posterior tibial* and *peroneal* artery, called also the *tibio-peroneal* artery, or simply the *posterior tibial* artery (*A. tibio-peronea*, s. *tibialis postica*, s. *tibialis poplitea*), descends vertically behind the interosseous membrane, covered by the heads of the peronei muscles, and generally, soon after the origin of the anterior tibial artery, gives off two considerable branches, an *external* and an *internal*.

The *internal* branch sends off small twigs to the popliteus muscle, penetrates principally into the tibia as the *upper nutritious* artery (*A. nutritia tibiæ superior*), and gives off from behind forward, into the periosteum of this bone, ramifications which anastomose on its internal face with those of the inferior and internal articular artery (§ 1509).

The *external* branch gives off ramuscules to the lower or middle head of the triceps suræ muscle, proceeds below it, around the upper extremity of the fibula, sends off ramifications to the upper part of the

peroneus longus muscle, and anastomoses both with the anterior tibial (§ 1511) and with the descending branches of the external inferior articular artery. These two branches consequently contribute to enlarge the system of the accessory vessels of the leg.

§ 1523. After giving them off, the tibio-peroneal trunk, which sends only inconstant branches to the soleus muscle, divides generally from one to two inches below the origin of the anterior tibial artery into two branches, the *peroneal* artery and the *posterior tibial* artery.

I. PERONEAL ARTERY.

§ 1524. The *peroneal* artery (*A. peronæa*, s. *fibularis*) generally but not always arises at the place mentioned. Sometimes, but much more rarely, and only when the popliteal artery divides unusually high, it arises above, more frequently below, this point, and in the second case it is smaller in proportion as its origin is lower. Sometimes, in fact often, it does not exist, and it is replaced by the branches which are successively given off from the posterior tibial artery. Independently of its point of origin it varies very much in respect to its volume, a circumstance in regard to which it increases and diminishes inversely with the anterior tibial artery. It is generally smaller than the two tibial arteries; but sometimes when one of the latter is deficient it is much larger than usual.

It descends on the posterior face of the interosseous ligament, covered by the soleus muscle, on the inside of the flexor longus digitorum communis muscle, gives its largest branches to these two muscles and also to the peronei, usually sends off, near the lower extremity of the leg, rather a large branch, which, passing under the posterior tibial artery, is called the *posterior internal malleolar* artery (*A. malleolaris interna posterior*) and goes to the internal malleolus, on the surface of which it frequently communicates with the anterior internal malleolar artery furnished by the anterior tibial artery (§ 1516) and terminates on the outer face and the tuberosity of the os calcis by ramuscules, which enter partly into this bone, and partly by large branches by which it anastomoses with the posterior tibial artery, thus forming the *inferior plantar arch*.

§ 1525. At various heights of the leg, but generally toward its lower extremity, it gives off a branch which also varies much in size and which goes to the anterior face of the limb, passing between the two bones. When this branch is considerable it is termed the *anterior peroneal* artery (*A. peronæa anterior*). It proceeds, near the surface, on the outer and anterior face of the leg, frequently descends to the external face of the tarsus, unites to the external malleolar artery, given off by the anterior tibial (§ 1515), concurs to form the dorsal arch of the tarsus, anastomoses with the branches of the external plantar artery, and distributes twigs to the tendons of the extensor digitorum communis, to the posterior part of the extensor minimi digiti

muscle, to the external malleolus, to the astragalus, and to the cuboid bone.

This branch does not always arise from the peroneal artery; it is then generally very small, and does not descend to the lower extremity of the leg or is entirely deficient. It is normally replaced by a branch of the anterior tibial given off by the external malleolar artery (§ 1515), less frequently although more commonly than when it arises from the peroneal artery, it comes from the posterior tibial artery, and then it passes at the usual place, on the anterior face of the leg.

The anterior peroneal artery much more rarely not only arises higher than usual, sometimes even not far from the middle of the anterior face of the leg, so that it sends off in this place ramifications to the peronei and to the extensor digitorum communis muscle, but it is also so large that it gives off the external malleolar artery; and the dorsal artery of the foot is even the continuation of its trunk, and then the anterior tibial artery is very small, terminates on the back of the tarsus, and anastomoses with it.

Not more frequently the peroneal artery extends farther than usual in the sole of the foot, and gives off the external and the internal plantar arteries. We have before us only one specimen of this anomaly. At the same time the anterior tibial artery is extremely small; it stops at the middle of the leg, and all the branches it generally gives off below this point arise from the posterior tibial artery, which passes to the anterior face of the limb, about the level of its lower fourth.

II. POSTERIOR TIBIAL ARTERY.

§ 1526. The *posterior tibial* artery (*A. tibialis postica*) is generally much larger than the peroneal artery, but its direction varies more than that of the primitive trunk, and it proceeds slightly inward. It is generally a little larger than the anterior tibial artery and sometimes very much exceeds it in size. It descends, covered above by the third head of the triceps suræ muscle, between this muscle, the flexor longus digitorum communis and the tibialis posticus, and is entirely loose at its lower part, being covered only by the crural aponeurosis and the skin and the posterior face of the tibia, on the inside of the tendo-Achillis. In its course it gives off posteriorly numerous small branches to the soleus muscle and the tendo-Achillis, and anteriorly to the tibialis posticus or flexor longus digitorum communis muscles. At the lower part of the leg it sends off several larger branches both outward and inward; these anastomose frequently, on the two malleoli, with the internal and external malleolar arteries, given off by the anterior tibial artery.

The posterior tibial artery, proceeding between the tendons of the flexor longus digitorum communis and the tibialis posticus muscles, situated on its inside, and that of the extensor pollicis pedis on the outside, so that it passes on the latter, leaves the posterior face of the leg, and arrives at the sole of the foot, where it is situated on the pos-

terior face of the os calcis. Very rarely it passes from the posterior to the anterior face of the leg, thus becoming the dorsal artery of the foot. It most generally sends off, at the place where it enters the sole of the foot, a considerable branch, which goes into the os calcis and also into the lower extremity of the tendo-Achillis; this branch anastomoses on the tubercle of the os calcis, before this tendon, with the final branches of the peroneal artery, and by means of them with the external malleolar artery; thus a vascular plexus is formed which may be termed the *inferior* or *plantar tarsal arch* (*rete*, s. *arcus tarsus plantaris*).

Not unfrequently another external and large branch goes to the posterior part of the abductor pollicis pedis muscle.

The posterior tibial artery then divides below the internal malleolus about the centre of the inner face of the calcaneum, but a little behind it, into two branches, the *external* and *internal plantar* arteries.

These two branches, and the two branches described previously, very rarely arise from the peroneal artery, which happens when the posterior tibial artery replaces the lower portion of the anterior tibial artery (§ 1525).

III. PLANTAR ARTERIES.

I. INTERNAL PLANTAR ARTERY.

§ 1527. The *internal plantar* artery (*A. plantaris interna*) is always smaller than the external, and varies in size less than the latter. It follows the direction of the trunk and goes forward, under the tendons of the flexor digitorum longus muscle, above the long head of the abductor pollicis, not far from the inner edge of the foot. In its course it sends superficial branches to the abductors and the flexor pollicis brevis, and to the flexor communis digitorum brevis, gives deep branches to the inner half of the plantar face of the ligamentous envelop of the tarsus, to the os calcis, to the astragalus, and to the scaphoid bone; anastomoses, in several places above the inner edge of the foot, with the branches of the internal artery of the tarsus and of the dorsal artery of the foot, and gives off anteriorly, between the first and second toes, generally one, often also two, branches, which form the plantar artery of the large toe, and frequently anastomoses, by an external branch, with the deep plantar arch.

II. EXTERNAL PLANTAR ARTERY.

§ 1528. The *external plantar* artery (*A. plantaris externa*) is deeper than the internal. It varies in size more than this latter. It is often scarcely visible, and again is sometimes three times the size of the internal. These differences depend principally on those in the size of the dorsal artery of the foot (§ 1517), for there is always an inverse relation between the caliber of these two vessels.

The external plantar artery immediately goes far outward. It proceeds between the abductor pollicis pedis and the flexor digitorum

brevis below, and the accessory muscle above, toward the outer edge of the sole of the foot, where it extends forward, on the inner edge of the abductor minimi digiti muscle, gives branches to all the muscles mentioned, and anastomoses, by several branches which reascend above the outer edge of the foot, with the arteries of the tarsus and metatarsus.

At the posterior extremity of the fifth metatarsal bone it goes inward, and gives off, either in this place or a little before, a considerable branch, the *peroneal plantar artery of the fifth toe* (*A. digitalis plantaris peronea digiti quinti*), which goes forward on the flexor minimi digiti muscle, along the fibular edge of the toes to the anterior extremity, sends branches to its flexor muscle, to the third internal interosseous muscle and to the skin, and finally anastomoses, on the ungueal phalanx of the little toe, with the tibial branch.

The deep or internal plantar artery then goes almost transversely forward and inward, between the internal interossei and the other muscles of the sole of the foot, and anastomosing with the deep anastomotic branch of the dorsal artery of the foot, between the first and second metatarsal bones, forms the *deep plantar arch*, which is concave backward and convex forward, and is situated very deeply on the posterior extremities of the metatarsal bones.

III. PLANTAR ARCH.

§ 1529. The *digital* arteries and the *anterior* and *posterior perforating* arteries arise from the deep palmar arch.

a. Digital arteries.

§ 1530. The *digital* arteries (*A. digitales*) arise forward from the convex part of the arch.

Their general characters are,

a. They are situated deeply in the sole of the foot, and proceed from behind forward, on the square belly of the flexor digitorum longus communis, and the transverse belly of the adductor hallucis.

b. Between the posterior extremities of the toes they divide into two branches, which go one to the tibial side of the outer, the other to the peroneal side of the inner toe.

c. The two branches unite on the ungueal phalanx, and also anastomose with each other and with the dorsal branches.

d. They anastomose forward with the superior and inferior metatarsal arteries at their bifurcation.

But they differ very much in regard to their origin. The deep arch most generally gives rise to the deep plantar arteries of the three outer and the peroneal branch of the second toe, less frequently to the tibial branch of this and the plantar branch of the large toe.

The peroneal branch of the little toe often comes directly from the plantar arch, and even farther behind it, from the external plantar artery (§ 1528), but it not unfrequently arises, by a common trunk, with the tibial branch of the fifth toe and the peroneal branch of the fourth. We have never observed that when this first digital artery gave off also the tibial branch, it was destined solely for the fifth toe, and did not proceed at the same time to the peroneal side of the fourth. Even when the peroneal branch of the fifth toe forms a distinct and separate trunk, it generally communicates by large anastomosing branches, both on the metatarsus and on the first phalanx of the toe, with the second digital artery, and the tibial branch of the fifth toe.

The *second digital* artery when it does not form a trunk with the preceding, goes to the tibial side of the fifth toe and to the peroneal side of the fourth.

Next comes the third, which goes to the tibial side of the fourth toe and to the fibular side of the third. Sometimes this artery is double as far as the arch from whence it arises to the anterior part of the metatarsus; but its two trunks there unite in one, which soon divides into two branches, the tibial branch of the fourth and the peroneal branch of the third toe. This arrangement occurs particularly when the usual number of digital arteries is diminished in any manner whatever, as, for instance, by the union in one trunk of the peroneal branch of the fifth toe and of the two following branches.

Next comes usually a fourth, which divides in the same manner for the second and third toes.

The fifth constantly forms the tibial branch of the second toe. Sometimes, when the anterior tibial artery is much smaller and the posterior on the contrary is larger than usual, it forms the *common plantar artery of the large toe*, from whence the tibial branch of the second also arises.

The plantar artery of the large toe and the tibial branch of the second vary the most in their origin and arrangement.

This artery is generally the continuation and termination of the trunk of the dorsal artery of the foot, which comes to the first phalanx of the large toe, goes to its plantar face, and gives origin to all the plantar and dorsal branches of this toe, sending off first the peroneal dorsal branch, then the peroneal plantar branch, next the tibial plantar branch, and finally the tibial dorsal branch, which anastomose as usual.

More rarely the continuation of the trunk of the dorsal artery of the foot divides, soon after giving off the deep anastomosing branch to the sole of the foot, into two branches, a superior, which becomes the common trunk of the dorsal artery of the large toe and the tibial branch of the second; an inferior, or the common trunk of the two plantar arteries of this toe, which bifurcates near the centre of the plantar face of the large toe, to give rise to two plantar branches. But we must remark that here we find a similarity between the anomaly and the normal or more common arrangement first described, since the two

branches communicate at the base of the first two toes by a large anastomosing branch.

The superficial internal plantar artery given off by the posterior tibial artery always contributes to form the two plantar branches of the large toe and the inner branch of the second; since it constantly anastomoses near the anterior extremity of the first metatarsal bone with the trunk of these branches, and thus forms the *superficial plantar arch* (*arcus plantaris superficialis*).

When the anterior tibial artery is smaller than usual, it sometimes but not always gives off only the dorsal artery of the large toe; sometimes too it sends off in part the tibial artery of the second. On the contrary, the trunk from which the plantar branches of the large toe and the plantar branch of the second arise, the *internal plantar* artery, is unusually large, and is always increased by a branch, which varies in size; this arises from the deep plantar arch and communicates with it toward the extremity of the first metatarsal bone.

Finally, sometimes but rarely all the arteries of the first and second toe arise only from the posterior tibial artery, particularly from the deep arch. The anterior tibial artery, which is very small, then terminates simply by a deep anastomosing branch in the deep plantar arch, and a large branch arises from the latter, which soon divides into two: one is deeper and larger, and is the continuation of the trunk; it goes from behind forward on the first metatarsal bone, and is also enlarged by one or two branches arising from the internal plantar artery, which is also in this case unusually large, and bifurcates to give rise to the common plantar artery of the large toe and also to the tibial artery of the second; the other is smaller and more superficial, ascends to the back of the foot between the first two metatarsal bones, gives off the dorsal branches of the large toe, and becomes, with a second digital artery given off by the deep branch, the common trunk of the tibial branch of the third toe and of the peroneal branch of the second.

b. Anterior perforating arteries.

§ 1531. The *anterior perforating* arteries (*A. perforantes anteriores*) arise on the anterior part of the deep plantar arch, sometimes between the digital arteries. They are small and go only to the interosseous muscles, to the transverse head of the adductor hallucis muscle, and the metatarsal bones. A part of its ramifications communicates anteriorly with the digital arteries and the dorsal artery of the foot.

c. Posterior perforating arteries.

§ 1532. The *posterior perforating* arteries (*A. perforantes posteriores*) arise from the posterior and upper surface of the deep plantar arch. They give branches to the posterior part of the interosseous muscles, and also recurrent branches to the anterior part of the tarsa

ligaments and bones, and passing through the posterior extremities of the interosseous spaces, come on the back of the foot, where they anastomose with the upper interosseous arteries.

These arteries are generally small, and can be considered only as the anastomoses between the dorsal and plantar arches. However, as these latter and the dorsal interosseous arteries are generally much larger than their corresponding parts in the hand, the posterior perforating arteries are sometimes unusually developed; so that the transverse tarsal artery sends only small anastomosing branches to their posterior extremities, in the place where they appear on the back of the foot. But in this case they are not the only origin of the dorsal interosseous arteries, which arise also from the plantar arteries of the toes and are much larger than the common trunks of the digital arteries, and which give all the digital branches commonly arising from the anterior side of the deep arch.

In this case the usual anterior branches of the plantar arch still exist, but they are merely branches for the deep muscles of the sole of the foot and the anterior perforating arteries; so that they are as slightly developed as the interosseous arteries generally are.

There are many degrees between this state of the dorsal interosseous arteries and the common one; so that for instance many or all the dorsal interosseous arteries contribute equally to form the digital arteries, and thus the dorsal and plantar arteries have about the same size, although it does not necessarily follow that the dorsal interosseous arteries arise from the deep plantar arch, as in the anomaly described. On the contrary, they sometimes become unusually large, but are however only the branches of the dorsal arch.

SECTION III.

OF THE VEINS OF THE BODY.

§ 1533. The *veins* of the body generally unite in three large trunks, which open into the right auricle (§ 1305), the *large coronary vein of the heart* and the two *venæ cavæ*.

CHAPTER I.

OF THE VEINS OF THE HEART.

I. LARGE CORONARY VEINS[1]

§ 1534. The *large coronary vein of the heart* (*vena coronaria maxima cordis*) opens into the right auricle, on the left and lower side of the interauricular septum, a little way from the venous orifice of the right

ventricle. It rarely empties itself into the left subclavian vein,* in which case the veins of the body do not unite except in two large trunks.

It arises from all the extent of the left ventricle by four or five considerable branches, which proceed downward from the summit to the base of the heart, and among which we observe three which are larger and longer than the rest.

The upper branch follows the upper groove of the convex face of the heart, which marks the upper edge of the septum. The second proceeds along its blunt edge, and the third near the inferior groove.

The smallest branches, which do not descend as low as the preceding, are situated between them.

All correspond to ramifications of the arteries, and empty at right angles into the trunk of the coronary vein, which proceeds in the transverse groove between the left ventricle and left auricle, first downward, then from behind forward to the place where it opens into the right auricle.

II. SMALL CORONARY VEIN OF THE HEART.

§ 1535. The *small coronary vein of the heart* (*V. coronaria cordis minor*, s. *Galeni*) belongs principally to the right auricle. It arises from the summit of the heart, proceeds in the lower longitudinal groove, or a little to the right, along the posterior and inferior edge of the right ventricle, receives the branches which come on the lower face of this ventricle, and almost always empties into the preceding, directly behind its opening. It rarely opens into the auricle, a little before the large coronary vein.

III. SMALL ANTERIOR VEINS OF THE HEART.

§ 1536. Besides these two large veins, others also, which are smaller and may be termed the *small anterior veins of the heart*, arise from the anterior ventricle, from the aorta and the pulmonary artery, and open separately into the anterior part of the right auricle. They extend from the summit to the base of the heart, proceeding before and above the preceding.

IV. SMALLEST VEINS OF THE HEART.

§ 1537. The *smallest veins of the heart* (*V. minimæ cordis*) convey the blood in every direction, even in the left half of the heart, but especially into the right auricle, through the *foramina of Thebesius* (*foramina Thebesii*).

* Le Cab, in the *Mém. de l'ac. des sc.*, 1738, *Hist.*, p. 62.

CHAPTER II.

VEINS OF THE HEAD AND UPPER EXTREMITIES.

§ 1538. The *veins of the head and of the upper extremities* all unite in the descending vena cava.

ARTICLE FIRST.

VEINS OF THE HEAD.

§ 1539. The *veins of the head* are distinguished into the *superficial* or *external* and the *deep* or *internal*. The latter convey the blood from the brain; the former return it from the other parts of the head. They terminate in two large trunks, the *internal* and the *external jugular* vein.

I. SUPERFICIAL VEINS OF THE HEAD.

§ 1540. Almost all the superficial or external veins of the head open into the external jugular vein. A very few of them accompany the arteries; the largest of them however differ a little in their distribution from that of the large arterial branches to which they correspond.

Those which resume the blood from the tongue, the pharynx, the skin, and the superficial muscles of the face, finally, from the sides and from the posterior part of the skull, unite in two large trunks, an anterior and a posterior, which correspond, the former to the facial artery (§ 1351), the latter to that part of the external carotid artery which is above the facial artery, and to its outer termination, or to the temporal artery (§ 1358). These two trunks unite toform one, which is short and corresponds to most of the external carotid artery, and is called the *common trunk of the superficial veins of the head* (*truncus communis venarum capitis superficialium*), or rather the *anterior cephalic* vein (*V. cephalica anterior*).

A. FACIAL VEIN, OR ANTERIOR BRANCH OF THE ANTERIOR VEIN OF THE HEAD.

§ 1541. The *anterior trunk of the veins of the head, the facial vein, the anterior and internal facial vein* (*R. venæ cephalicæ anterioris anticus*, s. *V. facialis anterior*, Walter) is formed by the veins of the anterior and much the larger part of the face.

It follows the direction of the facial artery, but is situated more behind than this vessel, and as it is less tortuous, it is also some distance from it.

Regarded from above downward, according to the course of the blood, this vein arises gradually by the union of the following branches:

The upper branches are two in number, an *anterior* and *internal* and a *posterior* and *external*. The first is called the *supra-orbitar* and the second the *frontal* vein.

I. SUPRA-ORBITAR VEIN.

§ 1542. The *supra-orbitar* vein (*V. supra-orbitalis*) is situated below the frontalis muscle, proceeds transversely along the upper edge of the orbit, anastomoses externally with the frontal branch of the temporal vein, and arises from several venous twigs, which come from the orbicularis palpebrarum, the corrugator supercilii, and the frontalis muscles.

II. FRONTAL VEIN.

§ 1543. The *frontal vein* (*V. frontalis*) arises,

1st. From the branches which anastomose with the final anterior branches of the temporal vein and also with the synonymous branches of the opposite side, form thus a very complex vascular net-work on the frontal region, and come from the frontalis muscle, from the skin, and the frontal bone. The trunk formed by the union of these branches which often unites, at the lower part of the squamous portion of the frontal bone, with the synonymous trunk of the opposite side, by a large anastomosis, and frequently forms a median branch.

2nd. From an inferior branch, the *superior dorsal vein of the nose* (*V. dorsi nasi superior*), which, after anastomosing very frequently with the inferior dorsal artery of the nose, ascends and unites with the superior branch, which we shall describe.

III. INFERIOR NASAL VEINS.

§ 1544. The supra-orbital and frontal veins unite in a common trunk in the inner angle of the eye, which descends along the nose directly below the skin.

This trunk receives from before backward and from below upward, below the inner angle of the eye, first, the *inferior dorsal vein of the nose* (*V. dorsi nasi inferior*), then the *upper anterior vein of the nose* (*V. nasalis anterior superior*), afterward the *lower anterior vein of the nose* (*V. nasalis anterior inferior*), which frequently anastomose together, and with the upper dorsal vein of the nose.

IV. CORONARY VEIN OF THE UPPER LIP.

§ 1546. The trunk of the facial vein next receives, as high as the ala of the nose, the *coronary vein of the upper lip*, which often forms a common trunk with the anterior and inferior nasal artery, and which frequently anastomoses with it.

V. LOWER INTERNAL PALPEBRAL VEIN.

§ 1546. The facial vein receives at its upper part, opposite the anterior and inferior nasal artery, the *internal and inferior palpebral* vein (*V. palpebralis inferior interna*). This vein is situated in the lower eyelid, between the skin and the orbicularis muscle; it forms a very complex net-work which anastomoses externally with the upper palpebral vein, given off by the temporal vein (§ 1551), and with the external palpebral vein.

VI. LOWER INTERNAL PALPEBRAL VEIN.

§ 1547, The *external inferior palpebral* vein (*V. palpebralis externa inferior*) descends directly under the skin, along the external edge of the orbicularis muscle, anastomoses within with the upper external palpebral vein furnished by the temporal vein, outward with the internal inferior palpebral vein, and, passing under the zygomaticus major muscle before the malar bone, empties into the trunk of the facial vein much deeper than the preceding.

VII. UPPER AND ANTERIOR INTERNAL MAXILLARY VEIN.

§ 1548. Some distance below this external inferior palpebral vein the facial receives the *upper and anterior internal maxillary* vein (*V. maxillaris interna anterior superior*), which arises from the upper teeth and from the upper maxillary bone, from the posterior part of the nasal fossæ, and from the lower and anterior part of the orbit, by the following branches :—

1st. The *upper alveolar* vein (*V. alveolaris superior*).

2nd. The *posterior nasal* vein (*V. nasalis posterior*).

3rd. The *anterior ophthalmic* vein (*V. ophthalmica superior*).

§ 1549. From this point to the lower maxillary bone the facial vein receives principally,

1st. The *lower* or *external vein of the upper lip* (*V. labii superioris inferior*, s. *externa*), which is much smaller than the internal.

2nd. The *upper buccal* vein (*V. buccalis superior*).

3rd. The *middle labial* vein (*V. labialis media*), which is transverse, and empties itself into the trunk opposite the angle of the lips.

4th. The *inferior labial* vein (*V. labialis inferior*).

5th. The *submental* vein (*V. submentalis*).

§ 1550. It receives upward and outward in its course,

1st. The *inferior buccal* vein (*V. buccalis inferior*).

2nd. Three or four *masseteric* veins (*V. masstericæ*), a *superior*, a *middle*, and an *inferior*, which arise from the substance of the masseter muscle, and form an extensive net-work on the surface of this muscle, which anastomoses with all the branches of the facial vein.

3rd. The *vein of the submaxillary gland* (*V. glandulæ maxillaris inferioris*).

B. COMMON TEMPORAL VEIN, OR THE POSTERIOR BRANCH OF THE ANTERIOR VEIN OF THE HEAD.

§ 1551. The *common temporal* vein, the *posterior branch of the anterior vein of the head* (*V. temporalis*, s. *R. primarius, venæ cephalicæ anticæ posticus*, s. *V. facialis posterior externa*, Walter), is formed partly of superficial and partly of deep branches. The former arise principally from the middle and lateral parts of the external face of the skull; the latter come from the deep regions of the face.

The following are the principal branches which unite below and backward to form the temporal vein :—

I. EXTERNAL UPPER PALPEBRAL VEINS.

§ 1552. One or two *external upper palpebral* veins (*V. palpebralis superior externa*) receive the blood from the tunica conjunctiva, the orbicularis palpebrarum, the skin of the upper eyelid, and frequently anastomose together, and also with the upper and lower external palpebral arteries, and the following.

II. EXTERNAL SUPRA-ORBITAL VEIN.

§ 1553. The *external supra-orbital* vein (*V. supra-orbitaria externa*) proceeds transversely over the upper edge of the orbit, under the orbicularis palpebrarum and the ligaments of the eyelids, and anastomoses with the external upper palpebral veins (§ 1552).

III. EXTERNAL FRONTAL VEIN.

§ 1554. The *external frontal* vein (*V. frontalis externa*) arises from the skin of the forehead, from the frontalis muscle, from the periosteum of the frontal bone, and, from this bone, anastomoses with the internal frontal vein (§ 1543) before, outward with the temporal vein, and communicates with the two or three preceding, at the outer extremity of the upper edge of the orbit.

IV. DEEP TEMPORAL VEINS.

§ 1555. These three branches are situated directly under the skin. The trunk which is formed by them, or the *deep temporal* vein (*V. temporalis profunda*), penetrates the aponeurotic envelop of the temporalis muscle, proceeds upward and backward under this aponeurosis, above the zygomatic arch, turns very frequently, receives in its course several branches which resume the blood from the temporalis muscle and the temporal bone, anastomoses frequently with those of the facial

vein, and communicates, before the external ear, and above the temporo-maxillary articulation, with the superficial temporal vein.

V. SUPERFICIAL TEMPORAL VEIN.

§ 1556. The *superficial temporal* vein (*V. temporalis superficialis*) is generally smaller than the preceding, and is formed by an anterior and a posterior branch, which are both situated directly under the skin. The first arises from the sinciput, the second from the upper part of the occipital region, from the upper part of the ear. They most frequently join at a right angle, and form a small common trunk, which is soon united with the deep temporal vein. These two branches frequently anastomose with each other. The anterior also communicates with the branches of the external frontal vein, and the posterior with the occipital vein.

VI. TRUNK OF THE TEMPORAL VEIN.

§ 1557. The common trunk formed by the union of the deep and superficial temporal veins, descends on the outer face of the malar bone, comes behind the ascending branch of the inferior maxillary bone, penetrates into the parotid gland, goes forward under the angle of the lower jaw, and anastomoses in this place with the facial vein or anterior branches of the veins of the head, and thus produces a short common trunk.

In this course it receives *anterior*, *posterior*, and *internal* branches.

VII. ANTERIOR BRANCHES.

a. Anterior articular vein.

§ 1558. The first anterior branch, counting from above downward, is the *anterior articular* vein (*V. articularis anterior*), which anastomoses very much with the deep temporal vein, and resumes the blood from the parts of the temporo-maxillary articulation.

b. Transverse facial vein.

§ 1559. The *transverse facial* vein (*V. facialis transversa*) empties into the trunk of the temporal vein, a little below the preceding: it is a considerable vessel, and generally arises by a *superior* and an *inferior* branch.

The *superior* branch arises from around the temporo-maxillary articulation, and anastomoses with the anterior articular vein (§ 1558), and with the external infraorbital vein.

The *inferior* branch arises from the superficial and the deep branches.

The *superficial* branches carry the blood from the parotid gland, from the outer face of the masseter muscle, from the skin of this region, and from the parotid canal, and anastomose with the maxillary veins.

The *deep* veins come from the pterygoideus externus muscle, and then go between the neck of the jaw and the posterior edge of the masseter muscle, where they communicate with the superficial branches.

c. Parotid veins.

§ 1560. The temporal trunk receives, much lower down and anteriorily, some small *parotid* veins (*V. parotideæ*).

VIII. POSTERIOR BRANCHES.

a. Anterior articular veins.

§ 1561. The posterior branches of the trunk of the temporal trunk, are, besides the following, the *anterior auricular* veins.) *V. auriculares anteriores*), which arise from most of the concha of the ear.

b. Internal and posterior maxillary vein.

§ 1562. The *deep* branch (*R. venæ facialis posterioris profundus*, Walter) corresponds mostly to the internal maxillary artery, furnished by the external carotid artery. We may then term it the *internal posterior maxillary* vein, to distinguish it from the anterior and superior maxillary vein (§ 1548). It is .formed by one or two inferior maxillary veins, and by four or five deep temporal veins, proceeds inward, before the common temporal trunk, backward and downward, and empties itself at some distance from the angle of the jaw, into the posterior part of the common temporal vein, after giving off a considerable branch, which descends and anastomoses with the external jugular and the occipital veins.

IX. LARYNGEAL VEIN.

§ 1563. The common trunk of the anterior and posterior veins of the face corresponds to the external carotid artery, and usually receives anteriorly a small branch, the *laryngeal* vein (*V. laryngea*) which arises from the mucous membrane, and from the muscles of the larynx and of the hyoid bone.

II. POSTERIOR CEPHALIC VEIN.

§ 1564. The *posterior cephalic* vein is formed principally by the veins of the brain, the tongue, and the pharynx.

I. VEINS OF THE BRAIN.

§ 1565. The *veins of the brain* may be divided into the *external* and the *internal*. The large branches produced by their union are all in-

serted in the pia mater of the brain, and carry the blood into trunks called *sinuses* (*sinus*) which are formed by the inner membrane of the veins and by the dura mater. These trunks are partly surrounded by the bones of the skull, have principally traverse and longitudinal directions, communicate by several smaller sinuses, which have no constant direction, carry the blood backward and downward, and finally open into the posterior cephalic vein.

It seems to us more proper to describe the sinuses before we mention the veins of the head.

a. Superior longitudinal sinus.

§ 1566. The *superior longitudinal* sinus (*sinus longitudinalis* s. *falciformis superior*) is the longest sinus of the brain, and is situated on the median line. It occupies the convex edge of the falx of the cerebrum, directly under the frontal suture, the sagittal suture, and the upper half of the squamous portion of the occipital bone, from the *cresta galli* process of the ethmoid bone to the internal occipital protuberance. It has the form of a triangle, the base of which is turned upward, the apex downward; it gradually enlarges from before backward very much, and terminates in the internal occipital protuberance, where it generally anastomoses with the right traverse sinus, in an irregular depression called the *torcular herophili*. We usually remark within a greater or less number of transverse cords (*trabeculæ*): these extend from one side to the other, and are formed internally by the dura mater, externally by the internal membrane which is reflected upon the latter.

The longitudinal sinus receives on each side in its inferior and lateral parts, ten or twelve veins, which arise from the upper and external face and from the internal face of the brain, and which proceed in the pia mater and principally above the grooves between the circumvolutions.

The veins of the outer and upper face are the largest and the most numerous. Before they empty into the upper longitudinal sinus, they receive those which ascend along its internal face. They always proceed from before backward, increasing considerably in volume.

Most of them, with the exception sometimes of the anterior, arrive at the longitudinal sinus at very acute angles and in a direction opposite to that of the blood which passes through it.

The posterior vein, also, before opening into the sinus, usually proceeds some distance, frequently an inch between the fibres of the dura mater, which separate to receive them, and in the intervals of which they frequently curve very much.

The curves of these posterior veins are also generally supplied with single more or less apparent valves, which the anterior do not possess, because as they open into the sinus more transversely, there is less danger of the regurgitation of the blood.

The superior longitudinal sinus also receives, above, a considerable number of little veins, some of which come from the bones, while others

pass through the skull, and establish the communication between the internal venous system of the head, and the external branches of the temporal and facial veins. This results from the numerous ramuscules, and especially those of one or two larger veins, which passing through the parietal foramina (*F. parietalia*) carry the blood from within outward.

Finally, the dura mater also gives venous branches, which empty into the upper and lateral parts of the superior longitudinal sinus.

b. Inferior longitudinal sinus.

§ 1567. The *inferior longitudinal* sinus (*S. longitudinalis*, s. *falciformis inferior*, s. v. *falcis inferior*) * is much smaller than the superior. It extends from the beginning of the middle third of the falx of the cerebrum to its posterior extremity, where it anastomoses, generally dividing into two trunks, the inferior of which proceeds along the lower and unattached edge of the cerebral falx, and empties itself into the anterior extremity of the fourth sinus, while the superior reascends between the layers of the falx and penetrates downward into the centre of the same sinus.

This sinus receives the veins of the falx, and in some rare cases some inferior veins of the internal face of the brain and of the corpus callosum.

c. Right sinus.

§ 1568. The *fourth*, *right*, or more properly the *oblique* sinus, the *sinus of the tentorium* (*S. rectus*, s. *perpendicularis*, s. *quartus*, s. *obliquus*, s. *tentorii*), properly speaking, is only the posterior part of the preceding, but it is much larger than it. It descends obliquely from before backward, on the middle of the tentorium of the cerebellum, and occupies all the space between it and the union of the superior longitudinal sinus (§ 1566) with the transverse sinuses (§ 1571).

It gradually becomes broader from before backward and is triangular.

The transverse and oblique cords are more numerous in the anterior part than they are in the superior longitudinal sinus.

Forward and upward it receives the inferior longitudinal sinus (§ 1567). The two large internal cerebral veins, or those of Galen (*V. magnæ Galeni*), also open into its anterior extremity, below the anterior and inferior root of the inferior longitudinal sinus.

d. Large internal sinus.

§ 1569. The large internal sinus takes up the blood from the inner parts of the encephalon, and is formed principally on each side by the

* Bichat, *Anat. desc.*, vol. iv.

union of two vessels, the choroid vein and the vein of the corpus striatum.

The first proceeds in the choroid plexus, along the pes hippocampi, goes forward with the choroid plexus between the corpus striatum and the posterior large cerebral ganglion, and receives in the latter part of its course numerous ramuscules of veins, which go from below upward, through the substance of the large cerebral ganglion, and extends to the anterior pillar of the fornix.

The second is formed by small veins, which arise from the substance of the large anterior cerebral ganglion or the corpus striatum. It goes from behind forward, in the channel grooved between the corpus striatum and the thalami optici, until it anastomoses by its anterior extremity with the corresponding extremity of the choroid vein.

It is sometimes double; the posterior then passes above the thalami optici, and usually opens into the vein of Galen.

The latter, arising from the point mentioned, proceeds directly from before backward, that is, in a direction contrary to that of the two branches which produce it, under the fornix in the prolongation of the pia mater, which penetrates within the brain, and on that of the arachnoid membrane, which accompanies it. It generally receives, near its posterior extremity, the superior and anterior veins of the cerebellum. It opens into the anterior extremity of the right sinus, very near that of the opposite side, with which it sometimes unites to form a trunk of but slight extent, the direction of which it sometimes but not always crosses.

e. Superior veins of the cerebellum.

§ 1570. The fourth sinus also receives the superior veins of the cerebellum, that is, the posterior, for the anterior empty in the veins of Galen.

These veins, which, like the anterior, cross the transverse grooves of the cerebellum, go backward, and the anterior forward. Proceeding at first from before backward and then forward, they penetrate to the posterior part of the fourth sinus, and sometimes also into the commencement of the transverse sinus.

f. Transverse or lateral sinuses.

§ 1571. The *transverse* or *lateral* sinuses (*S. transversi*, s. *laterales*) are the largest, and descend on each side, in the transverse groove of the occipital bone, anastomose there with the fourth sinus and also with the upper longitudinal sinus, and terminate in the foramen lacerrum, in the groove of the internal jugular vein.

That of the right side usually unites, but that of the left rarely with the superior longitudinal sinus to form a short common trunk. Sometimes also the posterior extremity of the latter passes directly between the two lateral sinuses.

That of the right side is most generally larger than that of the left.

We not uncommonly observe that one or even both of them is divided in a greater or less part of its course, by a transverse layer, into a superior and an inferior portion.

When this layer exists through the whole extent of the lateral sinus, the latter is completely double.

One of these two lateral sinuses is sometimes deficient. The superior longitudinal sinus then descends to the large occipital foramen, around which it turns to go to the posterior foramen lacerum.

The lateral and inferior veins of the cerebrum and the inferior veins of the cerebellum open into the lateral sinus.

The *lateral and inferior veins of the cerebrum*, the inferior cerebral veins, arise at nearly the centre of the skull, on the outside of the hemispheres, and usually unite in three trunks; these are joined by a fourth, which comes from the lower face of the posterior lobe, separate from the cerebrum, go forward, and open separately from above downward at about the centre of each lateral sinus.

The *inferior veins of the cerebellum* arise from the lower face of this organ, unite in two or three trunks, go backward and outward, and open from below upward into the transverse sinus.

g. Superior petrous sinus.

§ 1572. In the place where the transverse sinus touches the posterior extremity of the petrous portion of the temporal bone, and leaves its horizontal direction to go obliquely upward, we see detached, from its outside, a much narrower sinus, the *superior petrous* sinus (*S. petrosus superficialis*, s. *superior*), which proceeds downward, inward, and forward, along the upper edge of the petrous portion of the temporal bone, where it terminates in the cavernous sinus, consequently unites this and the transverse sinus by anastomosis.

h. Inferior petrous portion.

§ 1573. The *inferior petrous* sinus (*S. petrosus inferior*, s. *profundus*) arises at the lower extremity of the transverse sinus, directly above the posterior foramen lacerum, from the anterior side of this sinus; this is broader but shorter, and is situated between the anterior part of the petrous portion of the temporal bone, and the body of the occipital bone, and is almost wholly situated in a fossa hollowed from the latter bone, the posterior part of which is sometimes changed into a canal. This sinus proceeds from before backward and from without inward, which direction is preserved at its extremities better than in its centre; it opens into the back part of the cavernous sinus, and establishes another large anastomosis between it and the transverse sinus.

i. Cavernous sinus.

§ 1574. The *cavernous* sinus (*S. cavernosus*), a considerable dilatation and of a very irregular form, is situated, on each side, on the lateral part of the body of the sphenoid bone. It anastomoses posteriorly with the posterior extremities of the two petrous sinuses, forward with the coronary sinus, and backward with the anterior occipital sinus.

Its cavity has numerous soft reddish irregular filaments which intercross and are arranged in a reticular form, from whence it takes its name.

The internal carotid artery and the sixth pair of the cerebral nerves pass through it, covered by its inner membrane, which is reflected on them and unites them.

It receives superiorly the anterior and middle inferior cerebral veins, forward the ophthalmic veins, downward, on the sides, the venous branches from the dura mater.

k. Coronary sinus.

§ 1575. The *coronary* sinus (*S. circularis*, s. *coronoideus*) is generally much broader anteriorly than posteriorly, and surrounds the pituitary gland. Its anterior or posterior portion is often deficient. It is sometimes also partly double, which depends on the existence of a transverse branch which passes below the gland. It receives the vein from the pituitary gland, and sometimes also the ophthalmic veins.

l. Anterior occipital sinus.

§ 1576. The *anterior occipital* sinus (*S. occipitalis*, s. *basilaris anterior*) extends transversely on the posterior face of the basilar process, from the union of the two petrous sinuses on each side, and the posterior extremities of the cavernous and coronary sinuses to the corresponding point of the opposite side. It thus forms a considerable anastomosis between the sinuses of the two sides, and represents a second crown, situated below the preceding, which communicates below with the analagous sinuses of the vertebræ.

m. Posterior occipital sinus.

§ 1577. The *posterior occipital* sinus (*S. occipitalis*, s. *basilaris posterior*) is sometimes single, sometimes and more frequently double. In the latter case we find a right and a left. It extends from the inner extremity of the two transverse sinuses, and the external occipital protuberance, along the posterior edge of the circumference of the large occipital foramen, encircles the posterior and the lateral portions of this foramen, and anastomoses in front with the lower extremity of the

transverse sinus; so that it forms a greater or less anastomosis between the lower and the upper part of this sinus.

It is sometimes double at its summit and single in the centre, but it always divides very high up, above the occipital foramen, into a right and a left portion. It is generally not very large; but it is frequently broad, and then the transverse sinus is smaller in a direct ratio.

It sometimes but not very often replaces this sinus either on one or both sides.

In other subjects, on the contrary, we cannot trace it in the least.

§ 1578. The transverse sinuses empty through the posterior foramen lacerum into a very short common trunk, which may be termed the *internal* and *posterior cephalic* vein, or the *encephalic* vein (*V. cephalica interna posterior*, s. *cephalica encephalica*, s. *cerebralis*), and thus contrast it, according to the analogy of the arteries, to the external and anterior cephalic vein, or to the facial vein.

This trunk is situated very deeply, and descends outside of the trunk of the internal carotid artery, on the inside of the posterior belly of the digastricus muscle. It extends from the posterior foramen lacerum to the upper edge of the larynx, where it anastomoses with the anterior cephalic vein.

It receives anteriorly the pharyngeal and the lingual veins, which generally empty separately, although they often unite with each other and with the superior thyroid vein.

II. PHARYNGEAL VEIN.

§ 1579. The *pharyngeal* vein (*V. pharyngea*) descends on the posterior and lateral part of the pharynx, and anastomoses very frequently with that of the opposite side. It is often double on one side; in this case, one of the two most generally arises from the thyroid vein.

III. LINGUAL VEIN.

§ 1580. The *lingual* vein (*V. lingualis*) arises from the end of the tongue, enters between the mylo-hyoideus muscle, the genio-glossus muscle, and the submaxillary gland, proceeds along the upper edge of the hyoid bone, before the hyo-glossus muscle; thus its direction is backward, and it opens into the internal cephalic vein, either by a common trunk with the preceding, or below it.

III. INTERNAL JUGULAR VEIN.

§ 1581. The anterior and posterior cephalic veins unite near the hyoid bone, to form the *internal jugular* vein (*V. jugularis interna*), which might be more properly termed by analogy with the arteries, the *common cephalic* vein (*V. cephalica communis*). This vessel descends almost perpendicularly on the anterior and lateral part of the neck,

outside of the primitive carotid artery and the pneumo-gastric nerve, inside of the sterno-cleido-mastoideus and the omohyoideus muscles, comes to the anterior extremity of the clavicle under which it passes and unites with the subclavian vein, to form the trunk of the innominata.

I. SUPERIOR THYROID VEIN.

§ 1582. In this course the internal jugular vein receives some distance below the union of the external and internal cephalic veins, a vein sometimes single and sometimes double, which often forms a common trunk with the pharyngeal and lingual veins, this is called the *superior thyroid* vein (*V. thyroidea superior*) : it corresponds exactly in its distribution to the artery of this name, but differs from it very constantly in its termination. It always empties into the common trunk of the external and internal cephalic veins. It not unfrequently divides, some distance from its insertion, into an upper and a lower branch, one of which ascends and the other descends. The superior thyroid artery, however, sometimes imitates the vein in this respect, and this anomaly frequently occurs, because it resembles the normal form of the vein.

II. INFERIOR THYROID VEIN.

§ 1583. The internal jugular vein also receives in its course, one or two *inferior* or *middle thyroid* veins (*V. thyroideæ mediæ*, s. *inferiores*, s. *descendentes*), which arise from the outside of the lower half of the thyroid vein and empty higher or lower into it.

This formation is remarkable also, as the superior or the inferior thyroid artery sometimes partially or wholly arises on one or both sides, from the common trunk of the carotid arteries, and consequently resembles the normal arrangement of the veins.

IV. EXTERNAL JUGULAR VEIN.

§ 1584. The *external jugular* vein (*V. jugularis externa*) is much smaller than the internal, and forms the superficial or cutaneous vein which corresponds to the latter. It arises as high as the angle of the lower jaw, from the back side of the internal, goes outward under the parotid gland, and receives first in this place the *posterior auricular* vein (*V. auricularis posterior*), and then descends vertically between the platysma myoides and the sterno-cleido-mastoideus muscles, crosses the direction of the latter, and is placed on the inside of the omohyoideus muscle. Its lower portion corresponds to the inside of the sterno-cleido-mastoideus muscle, and is much deeper than the superior. It opens into the subclavian vein outside of the internal jugular vein. In order to this, it generally passes on the inside of the clavicle, but it is also sometimes reflected on this bone, from without inward.

Its lower extremity is often divided into two branches which ascend more or less high.

Not unfrequently that part of its upper extremity which we have before mentioned as being that by which it arises from the internal jugular vein, is only a small anastomotic branch, and the external jugular vein is so large above this point, that it receives the common trunk of the temporal vein and of the posterior internal maxillary vein, which does not enter as usual into the anterior cephalic vein.

I. SUPERIOR SUPERFICIAL OCCIPITAL VEIN.

§ 1585. The external jugular vein receives a little way below the inferior posterior auricular vein (§ 1584) the *superior superficial occipital* vein (*V. occipitalis superficialis superior*), which descends between the skin and the occipitalis muscle.

Next come some deeper branches, which arise from the lateral and posterior muscles of the neck.

II. INFERIOR SUPERFICIAL OCCIPITAL VEIN.

§ 1586. The *inferior superficial occipital* vein (*V. occipitalis superficialis superior*) arises behind the superior, between the trapezius and the splenius muscle, some distance behind the external jugular vein, descends and empties into the latter at the lower part of the neck.

III. POSTERIOR AND SUPERIOR SCAPULAR VEINS.

§ 1587. Below, the external jugular vein receives posteriorly, the *superior* and the *posterior scapular* veins which accompany the arteries of the same name, and anastomose together and with the cephalic vein of the arm.

IV. ANTERIOR CUTANEOUS VEINS.

§ 1588. Before, it receives the *anterior cutaneous veins of the neck*, distinguished into the *upper*, the *middle*, and the *lower*. These veins arise from the skin and the anterior muscles of the neck, and frequently anastomose above with the inferior branches of the facial veins.

ARTICLE SECOND.

VEINS OF THE UPPER EXTREMITIES.

§ 1589. The blood of the upper extremities returns to the heart by the deep and the superficial veins.

I. DEEP VEINS.

§ 1590. The *deep* veins follow the arteries of the same name, each of which is usually attended by two veins which proceed at its sides.

II. SUPERFICIAL VEINS.

§ 1591. The superficial or the cutaneous veins are much larger than the preceding, and proceed under the skin, between it and the brachial aponeurosis.

Their roots, or the *digital* veins, arise principally from the back of the fingers, where we find from six to eight branches, situated at the side of one another, which frequently anastomoses together. These branches also receive the largest veins which proceed along the palmar face of the fingers, which, at the height of the second or the first phalanx, leave this face to go to the dorsal.

We may refer these veins to two principal trunks, the *radial* vein and the *ulnar vein*.

I. CUTANEOUS RADIAL VEIN.

§ 1592. The *cutaneous radial* vein, or the *brachial cephalic* vein (*V. brachialis radialis cutanea*, s. *cephalica*), arises from the thumb and the index finger, and is called the *cephalic vein of the thumb* (*V. cephalica pollicis*) proceeds on the back of the hand, in the space between the first two metacarpal bones, at first along the radial edge of the forearm, then along the anterior side of the arm, outside the biceps flexor muscle, passes between the pectoralis major and the deltoides muscle, and empties in the subclavian vein, below the clavicle.

II. CUTANEOUS ULNAR VEIN.

§ 1593. The *cutaneous ulnar* or *basilic* vein (*V. brachialis cutanea ulnaris*, s. *basilica*) arises from the dorsal face of the third finger, often also from all the space between the back of the index and that of the little finger, and forms on the back of the hand, a considerable network, which anastomoses in front with the cephalic vein of the thumb. Sometimes, when it comes on the back of the carpus, it goes forward toward the radius, and anastomoses, from the lower extremity of the forearm, with the preceding, with which it always communicates on the anterior and posterior faces of the limb, by means of several large branches, which form a broad network. It almost always forms in the forearm the *anterior cutaneous ulnar* vein (*V. ulnaris cutanea anterior*) and the *posterior cutaneous ulnar* vein (*V. ulnaris cutanea posterior*), the latter being generally larger than the former.

After leaving the articulation of the elbow it ascends, under the brachial aponeurosis, on the inside of the arm, along the ulnar nerve which it covers, and empties into the lower extremity of the axillary vein.

III. MEDIAN VEIN.

§ 1594. The *median* vein (*V. mediana*) is a large branch which serves to anastomose the radial and ulnar veins and also the superficial and the deep veins of the arm. It is generally single, but is sometimes double : its length varies, and it extends obliquely upward and backward, from the ulnar to the radial vein, as high as the flexor carpi ulnaris muscle. It generally sends one or more considerable branches, which anastomose with the anterior part of the deep brachial vein, or of the deep radial or ulnar vein. These branches are sometimes replaced by others of the cutaneous radial vein. The lower part of this vein is called the *median cephalic*, and its upper part the *median basilic* vein.

Sometimes the median vein ascends on the anterior face of the forearm, between the cephalic and the basilic vein, with which it communicates by numerous anastomoses ; it is generally termed the *common median* vein (*V. mediana communis*).

III. AXILLARY VEIN.

§ 1595. The *axillary* vein (*V. axillaris*) arises at the lower extremity of the axilla, from the union of the basilic with one of the brachial veins, most frequently the internal and posterior. It ascends directly before the axillary artery, receives in the centre of its course the second vein of the arm, the external thoracic and subscapular veins, finally comes under and behind the clavicle, and is called the subclavian vein when it reaches the upper extremity of the serratus magnus muscle.

IV. SUBCLAVIAN VEIN.

§ 1596. The term *subclavian* vein (*V. subclavia*) is usually applied to all that part of the system of the descending vena-cava which is included between the latter and the upper extremity of the axillary vein. Some anatomists, as Bichat, consider the upper part of the veins of the pectoral extremity, which extends to the scalenus anticus muscle, as also belonging to the axillary vein, and consider the subclavian vein as commencing only on this place, contrary to all analogy with the arrangement of the arteries. It would be more proper then to confine it to the external portion of this trunk, which extends from the upper extremity of the serratus posticus to the scalenus anticus muscle.

This proper subclavian vein receives the external jugular vein, which then empties into it (§ 1584) from below upward.

ARTICLE THIRD.

INNOMINATA VEIN.

§ 1597. The *innominata* vein (*V. anonyma*) is generally known as the subclavian vein; but it is more convenient to conform with the analogy of the arteries, and to apply to it the first term. It is formed on each side by the union of the internal and external jugular and the subclavian veins. The scalenus anticus muscle separates it from the corresponding artery; it passes before this muscle while the artery proceeds behind it.

The left innominata vein is nearly twice as long as the right. It goes almost transversely or at least very obliquely downward and to the right, directly before and above the arch of the aorta, and above the upper edge of the sternum, leaving the sternal extremity of the left clavicle.

The right leaves the sternal extremity of the right clavicle, goes more vertically downward and to the left, unites at an acute angle with that of the left side, above the cartilages of the first rib, and thus gives rise to the descending vena-cava.

We may consider the inner third of the left subclavian vein as corresponding to the upper part of the arch of the aorta. The trunk of the descending vena-cava represents the beginning of this latter artery. The innominata vein of the right side corresponds perfectly to the innominata artery.

The innominata vein receives on each side the *vertebral*, the *superior intercostal*, the *internal mammary*, the *superior diaphragmatic*, the *thymic*, the *superior cardiac*, and the *lowest thyroid* veins.

I. VERTEBRAL VEIN.

§ 1598. The *vertebral* vein (*V. vertebralis*) accompanies the vertebral artery, before which it is placed. It anastomoses above with the occipital sinus, in its course from above downward and inward, by intermediate branches, with the vertebral sinuses of the neck, resumes the blood of the deep muscles of the neck by external branches, and often divides, at its lower extremity, into two roots, of which the upper emerges with the vertebral artery, through the vertebral foramen of the sixth cervical vertebra, while the lower emerges from that of the seventh either alone or at least attended only by a small arterial vessel.*

According to Bichat, that of the right side passes before, and that of the left side behind the pneumo-gastric nerve and the subclavian artery.

* Eustachius, *De ossibus*, in *Opp. omn.*, p. 191.

But this arrangement is by no means general. At most, the inferior root of the right vertebral vein, which passes through the vertebral foramen of the seventh cervical vertebra, usually goes behind these parts.

II. SINUSES OF THE VERTEBRAL COLUMN.

§ 1599. The *sinuses of the vertebral column* (*S. columnæ vertebralis*)* are situated on the posterior face of the bodies of the vertebræ, before the dura mater, are formed by two long lateral trunks and by numerous transverse anastomosing branches, which are not, like the sinuses of the skull, formed by the dura mater of the inner membrane of the veins, and which, instead of adhering intimately to the memingeal sinus, are retained between it and the bone by a loose cellular tissue.

The two trunks descend on the two sides of the posterior face of the bodies of the vertebræ, empty principally into the vertebral vein, with which they continue through the anterior condyloid foramen of the basilar bone, empty also the blood into the anterior occipital sinus, with which they communicate at least by considerable anastomoses, contract very much on the intervertebral ligaments, especially in the lumbar region, diminish singularly in calibre at the sacrum, approach each other in this place, and arise by several minute branches from the fat which surrounds the dura mater.

They anastomose together on each vertebra by several large *tortuous transverse* branches (*circelli venosi*). Hence each of these bones has a proper venous crown, similar to that at the base of the skull, and corresponds finally to the whole venous system of the interior of the skull, and opens externally into the adjacent veins, between each pair of vertebræ.

The two longitudinal trunks are also united at their inferior extremity by a large transverse posterior branch, which corresponds to the anterior transverse branch of the coronary sinus of the skull (§ 1575).

These trunks anastomose outwardly with the posterior branches of the vertebral, intercostal, lumbar, and sacral veins, through the intervertebral foramina. The transverse branches receive anteriorly numerous branches, which come from the substance of the bodies of the vertebræ, and posteriorly those which arise from the dura mater.

The branches which enter the external veins, which we have mentioned first, carry outward the blood which the sinuses of the vertebral column have received from the dura mater and from the vertebræ.

From this description it follows that each vertebra, consequently also each corresponding section of the spinal marrow, particularly in the early periods of life when the spinal cord occupies the whole vertebral column, has its proper venous system, and that all these systems anastomose together and form a chain of rings.

* G. Breschet, *Essai sur les veines du rachis*, Paris, 1819.

III. SUPERIOR INTERCOSTAL VEIN.

§ 1600. The *superior intercostal* vein (*V. intercostalis suprema*) is almost as large as the azygos vein (§ 1605), is much larger on the left than on the right side, and is often only a branch of the vertebral vein. When it is distinct and separate from the latter, it empties from below upward into the trunk of the innominata. Its roots extend below the eighth rib. It arises from the intercostal spaces, the left lung, the left bronchial vein, the esophagus, the aorta, &c., and anastomoses by its lower branches with the right and left azygos veins, unites to the first, and always proceeds at the left side of the second. It is as much longer as the left azygos vein is shorter, and resembles the right azygos vein as the branches of anastomosis between it and the left are larger. It proceeds downward, along the vertebral column, behind the pleura.

§ 1601. The internal mammary vein, the superior diaphragmatic vein, &c., correspond precisely to the arteries of the same names. The lowest thyroid vein alone differs.

IV. LOWEST THYROID VEIN.

§ 1602. The innominata veins receive from above downward, usually on the right and left, or at least on one side, the *lowest thyroid* vein (*V. thyroidea ima*). The right is nearer the outer extremity of the right innominata vein than the left is to that of its own; and the latter almost corresponds to the median line, while the other is thrown still more to the right, although the latter arises from the left lobe of the thyroid gland.

Its constant existence deserves attention, because the lowest thyroid artery, which is not common, is a repetition of it.

CHAPTER III.

TRUNK OF THE SUPERIOR VENA-CAVA.

§ 1603. The *superior or descending vena-cava* (*V. cava superior*, s. *descendens*) is formed by the union of the two innominata veins, a little above the arch of the aorta, near the cartilage of the first rib on the right side. Thence it descends to the upper and right part of the right ventricle. Its direction is nearly vertical, a little oblique however from right to left and from behind forward. It proceeds on the right side of the aorta, and it is enclosed for the space of about two inches in the sac of the pericardium. Its upper part is loose and covered on the right by the summit of the right lung, on the left by the aorta, backward by the right superior pulmonary vein, forward by the cartilage of the upper eighth rib of the right side. It is situated entirely on the right.

§ 1604. This is its usual arrangement; but sometimes, although very rarely, we find two descending venæ-cavæ, and then the two trunks of the innominata vein are not united. We have before us two instances of this anomaly, which has been mentioned also by Bœhmer,* Murray,† and Niemeyer.‡ In this case the right descending vena-cava descends before the aorta, turns backward and outward around the left auricle, comes on the lower face of the heart, goes forward in the circular groove, reaches the right auricle, and opens into its lower and posterior part.

This anomaly is very curious, on account of its analogy with what is seen in several mammalia and in several reptiles.

CHAPTER IV.

AZYGOS VEIN.

§ 1605. The descending vena-cava receives no branch in the pericardium: at least it is extremely rare that the azygos vein empties into it within the pericardial sac.§

But directly after leaving the pericardium, it receives at its posterior part the *azygos* vein (*V. azygos*, s. *sine pari*), which opens still more rarely into the right auricle than into that portion of the vena-cava enveloped by the pericardium, and it more frequently opens into the vena-cava much higher than usual.

This vessel forms a large anastomosis between the descending and the ascending vena-cava, for it arises from the latter by numerous branches, and empties into the former.

It does not perfectly deserve its name, since we find on the left side also a vessel which corresponds to it, the *small semi-azygos* vein (*V. hemiazygos*): this latter does not however extend as high.

In the cases where this vein is thought to be doubled,‖ there is no new and unusual trunk, but generally, only a simple change in respect to capacity. This second azygos vein, which always exists on the left side, is only an extraordinary development of the left superior intercostal vein, which constantly anastomoses by considerable branches with the right and left azygos veins. In this case there is only a diminution, a contraction of the branches which anastomose between the common left and the right azygos vein, and likewise between the latter and left superior intercostal vein, with a considerable increase of the left azygos vein, whence a trunk is formed which occupies the left side, but which always empties into the corresponding subclavian vein at the usual place.

* *De confluxu triarum venarum cavarum*, Halle, 1763.
† *Neue Schwedische Abhandlungen*, vol. ii. p. 286.
‡ *De fœtu puellari difformi*, Halle, 1814.
§ Cheselden, *Phil. Tr.*, No. 337.
‖ See our *Handbuch der pathologischen Anatomie*, vol. ii. p. ii. p. 127.

We have sometimes observed, in a similar case, a very curious formation, the insertion of the right azygos vein much higher than usual, and once even in the trunk of the vena-innominata of the right side.*

This greater development of the left azygos vein, and its union with the left upper intercostal vein in a common trunk are not rare, but the lateral insertion of this vessel is much less common; here the right azygos vein empties into the left, which is much larger, and its trunk does not terminate in the descending vena-cava, but in the left subclavian vein.†

The azygos vein arises below on the two sides, by considerable branches, either directly from the ascending vena-cava, or from the renal or the first lumbar veins, most generally by several of these vessels at once.

The trunks formed by the union of these branches, the right and the left, the former of which is the *proper*, or rather the *right azygos* vein, and the latter the *semi-azygos*, or more properly the *left azygos* vein, pass, sometimes with the aorta through its opening, sometimes more outwardly, through the diaphragm.

The trunk of the right side proceeds forward and to the right on the side of the esophagus, before the right intercostal arteries, on the anterior face of the vertebral column. It receives behind and on the right the ten or eleven inferior intercostal veins, of which the inferior ascend, the central are transverse, and the superior descend. Two or three of the latter generally unite in a single trunk. They all proceed below and before the intercostal arteries.

The right azygos vein receives anteriorly the esophageal and the right bronchial veins.

It receives on the left side, and nearly upon the seventh or the eighth dorsal vertebra, the semi-azygos or the left azygos vein, which passes behind the thoracic canal and on the vertebral column to come to it, after receiving the five or six inferior intercostal veins.

This left azygos vein is sometimes double; when this is the case, another, which is superior and smaller, anastomoses with it, and empties into the right azygos vein, when the superior left intercostal vein is smaller than usual.

The right azygos vein anastomoses, by transverse branches, on the anterior face of the bodies of the vertebræ, with the superior intercostal vein.

Similar anastomoses exist also between it and the left trunk, so that the formation of the venous system on the anterior face of the bodies of the vertebræ resembles that on their posterior face.

* Wrisberg has once observed the same thing (*loc. cit.*, vol. i. p. 136). This arrangement of the right azygos vein does not necessarily exist whenever the left is unusually developed.

† We have seen this case once. Wrisberg is the only author (*loc. cit.*, obs. iii. p. 142-145) who mentions it.

CHAPTER V.

VEINS OF THE LOWER EXTREMITIES.

§ 1606. The veins of the lower extremities like those of the upper extremities, are divided into deep and superficial veins.

I. DEEP VEINS.

§ 1607. The deep veins which accompany the arteries, and with which they are closely connected on both sides, are double almost to the knee, but in such a manner that the two synonymous veins already unite with each other at some distance from their upper extremity. After leaving the ham they are single.

I. POPLITEAL VEIN.

§ 1608. The *popliteal* vein (*V. poplitea*) is single, and arises from the union of the anterior and posterior tibial and fibular veins ; it is situated backward and a little on the outside of the popliteal artery. It is more superficial than this artery, and intimately adheres to its parietes.

II. CRURAL VEIN.

§ 1609. The *superficial crural* vein (*V. femoralis superficialis*), by which term the preceding vein is designated, after it passes through the tendon of the adductor magnus muscle, comes on the inside of the crural artery, which partly covers it ; it is then situated more deeply than this artery.

III. DEEP CRURAL VEIN.

§ 1610. The *deep crural* vein (*V. femoralis profunda*) is generally more superficial than the artery of the same name.

IV. COMMON CRURAL VEIN.

§ 1611. The superficial and the deep crural veins unite and give origin to the *common crural* vein (*V. crucialis*, s. *femoralis communis*), which is situated more inward and backward, and consequently more deeply than the corresponding artery. It is placed on the inside of this vessel, and is separated from it by the crural nerve. It passes under the crural arch to enter the abdomen.

II. SUPERFICIAL VEINS.

§ 1612. There are two superficial veins called the *saphenæ* (*V. saphenæ*), which carry back the blood from the skin of the lower extremities. They are distinguished into external and internal.

I. INTERNAL SAPHENA VEIN.

§ 1613. The *internal saphena* vein (*V. saphena*, s. *saphena interna*, s. *magna*, s. *cephalica pedis*) arises by a deep branch, situated below the layer of cellular substance, from most of the inside of the toes, like the superficial veins of the arm, and is composed on the back of the foot of several branches, which form a considerable net-work; it proceeds forward and backward along the internal and upper part of the tarsus, passes from the internal malleolus to the internal and anterior part of the leg, thus comes behind the inner condyle of the femur, then goes to the inside of the thigh, ascends along its inferior part before the gracilis or the adductor longus muscle, passes through the *fascia lata aponeurosis*, about one inch below the crural arch, and empties outward and backward into the common crural vein.

A second branch which is more superficial, and situated directly below the skin, arises from the inner and anterior part of the leg, sometimes also only from the inside of the tibio-tarsal articulation, often anastomoses with the preceding in this place, ascends on the anterior internal side of the thigh, and unites with the preceding, directly below its confluence with the crural vein. There it receives the superficial internal crural vein, and also most of the external pudic and subcutaneous abdominal veins, which descend outward to come to it.

II. EXTERNAL SAPHENA VEIN.

§ 1614. The *external saphena* vein (*V. saphena externa*) is much smaller than the internal with which it communicates at its origin. It arises on the outside of the back of the foot, goes backward and upward under the external malleolus, approaches the tendo Achillis, reaches the centre of the posterior part of the summit of the leg, is situated in the ham on the inside of the tibial nerve, and empties a little above into the popliteal vein.

III. EXTERNAL ILIAC VEIN.

§ 1615. The *external iliac* vein (*V. iliaca externa*, s. *anterior*) is the direct continuation of the common crural vein, (§ 1612) and ascends behind and on the inside of the external iliac artery and along the iliacus internus muscle. At its lower extremity it receives the epigastric and the circumflex iliac veins.

IV. HYPOGASTRIC VEIN.

§ 1616. The *hypogastric* vein (*V. hypogastrica*, s. *iliaca posterior*, s. *inferior*) arises by branches which correspond to those of the hypogastric artery, from the external and internal parts of the pelvis, consequently from the glutei muscles, the genital organs, the bladder, and the lower part of the rectum. The umbilical arteries which are the continuation of the hypogastric trunk in the fœtus, alone have no corresponding vein, as the umbilical vein goes to the liver.

The twigs are here very considerable in proportion to the branches, so that these vessels form *plexuses*, which are termed according to the parts whence they arise, the *hemorrhoidal plexus* (*plexus hemorrhoidalis*), the *internal and external pudic plexus* (*P. pudendalis internus et externus*), the *vesical plexus* (*P. vesicalis*), the *sacral plexus* (*P. sacralis*), the *vaginal plexus* (*P. vaginalis*), and the *uterine plexus* (*P. uterinus*).

V. PRIMITIVE ILIAC VEIN.

§ 1617. The external iliac and hypogastric veins unite to form a short trunk called the *primitive iliac* vein (*V. iliaca primitiva*, s. *communis*). This trunk proceeds from below upward, and from without inward. It unites at an obtuse angle with that of the opposite side, on the anterior face of the fifth lumbar vertebra, and on the right to form the ascending vena-cava.

The right trunk is shorter than the left, exactly as the common trunk of the subclavian and jugular veins on the right side, a little less so however than the latter. It also ascends a little more vertically.

The right is placed behind and outside of the primitive iliac artery, the left behind and on the inside of this artery, before which its upper part passes.

These two trunks always unite below and on the right of the bifurcation of the primitive iliac artery, so that the upper part of the left primitive iliac vein is situated below the commencement of the right primitive iliac artery.

CHAPTER VI.

ASCENDING VENA-CAVA.

§ 1618. The *inferior or ascending vena-cava* (*vena-cava inferior*, s. *ascendens*) extends from the fourth or fifth lumbar vertebra, to the lower part of the right auricle. It is always much larger than the superior. In its whole course, it is situated on the right of the vertebral column, at the side of the aorta which is partly covered by it.

Below and in most of its extent, it proceeds perpendicularly upward, but its upper part inclines to the right, so that it there takes an oblique

direction. This part is situated in a particular depression of the posterior edge of the liver, sometimes even it is surrounded entirely by the substance of this gland, from which it can be easily separated.

Directly below the liver, it passes through the square opening of the diaphragm, enters the chest, and opens there directly from below upwards, into the right auricle.

§ 1619. This is the common arrangement of the ascending vena-cava.

The anomalies it presents, relate to the *number*, the *situation*, and the *insertion* of the vessel.

1st. A rare anomaly is where the ascending vena-cava divides into two trunks; it presents several degrees.

The least anomaly seems to be that where the left side of the ascending vena-cava gives off, a little below the renal veins, a vessel which ascends behind the aorta to go to the left renal vein, with which it anastomoses, so that these two veins form around the trunk of the aorta a plexus, whence arise all the renal veins of the corresponding side.

We have seen this arrangement several times. In fact there seems then to be a double renal vein; but when we consider that this vessel passes behind the aorta to empty itself into the upper renal vein, and when we regard the following series of anomalies, we cannot but consider it as indicating the doubling of the trunk of the ascending vena-cava.

We sometimes see too, in the place where the ascending vena-cava arises from the confluence of the two primitive iliacs, an accessory vessel which varies in size, and ascends on the left of the aorta, and opens either into the vena-cava or into the left renal vein.*

When the division is more marked the two trunks which proceed on the right and the left of the aorta are still more similar. Zimmermann,† Wilde,‡ and Pætsche,§ have described cases of this kind. The division always commenced as high as the renal veins, and the two trunks anastomose together, on the fifth lumbar vertebra, by a small transverse branch.

The division of the ascending vena-cava into two trunks more rarely depends on the fact that the hepatic veins do not unite with it. The first degree of this anomaly is where the hepatic veins open into the ascending vena-cava higher than usual, above, and not below, the diaphragm, as Huber‖ and Morgagni¶ have observed. It exists in the highest possible degree when the trunk of the hepatic veins empties the blood into the right auricle.**

* Morgagni, *De sed. et caus. morb.*, ep. 47, a. 30.—Pohl, *De venar. var.*, 1773. We have seen this anomaly several times.

† *De notandis circa naturæ humanæ machinæ lusis*, Duisburg, 1750, p. 54, 55.

‡ *Comm. Petrop.*, vol. xli. p. 312, vol. viii. fig. 1, 2.

§ *Syllogæ, obs. an.*, in the *Hall. coll. dis.*, vol. vi.

‖ *Obs. anat.*, Cassel, 1760, p. 34.

¶ *De sed. et caus. morb.*, ep. 60, a. 6.

** Rothe, in the *Abh. der Joseph Akad.*, vol. i. p. 265.

All these anomalies are remarkable, as they establish an analogy between man and most reptiles and fishes, and also between the abdominal and the thoracic veins.

2nd. The ascending vena-cava exists sometimes on the left, and not on the right side of the vertebral column, not only where the viscera generally are inverted, but even when the latter case does not exist.*

3rd. The anomaly is greatest when the vein opens into the left auricle,† which depends on the development being arrested.

§ 1620. The ascending vena-cava receives the *lumbar*, the *spermatic*, the *splenic*, the *capsular*, the *inferior diaphragmatic*, and the *hepatic* veins.

I. LUMBAR VEINS.

§ 1621. There are three or four *lumbar veins* (*V. lumbares*) which correspond to the lumbar arteries and empty into the ascending vena-cava. The left, which pass behind the aorta, are longer than those of the right. All anastomose with each other, and with the vertebral sinuses, through the intervertebral foramina (§ 1599).

II. SPERMATIC VEINS.

§ 1622. The *spermatic* veins (*V. spermaticæ*) usually open the right into the anterior part of the ascending vena-cava, some distance below the right renal vein; the left opens more externally than the preceding into the left renal vein.

These veins, particularly the left, are divided at a greater or less distance from their union, an arrangement remarkable as being a greater development of the type of the left side. Hence results a plexus called the *corpus pampiniforme*.

III. RENAL VEINS.

§ 1623. The *renal* or *emulgent* veins (*V. renales emulgentes*) are usually single, and are numerous more rarely than the arteries, even where the latter vary. They are situated also farther forward than they.

The left is much longer than the right. It arises higher than it, opens into the vena-cava at more of a right angle, and usually passes before the aorta to go to it.

We not unfrequently find it behind the aorta,‡ an anomaly, to which that leads where the vein divides into an anterior and a posterior trunk, which pass, the latter behind, the former before the aorta, beyond which they are frequently again blended into one.

* Morgagni, *Ep. anat.*, m. 56, a. 31.

† Ring, in the *Med. and phys. journ.*, vol. xiii, p. 120.—Lemaire, in the *Bull. des sc. méd.*, vol. v. 1810.

‡ Albinus, *Annot. acad.*, b. vii. c. 2.—Sandifort, *Obs. an. path.*, b. i. c. 5; b. iv. c. 8. We have often seen this anomaly.

IV. CAPSULAR VEINS.

§ 1624. The *capsular* veins (*V. capsulares*) open, the right always into the ascending vena-cava, the left, on the contrary, into the left renal vein, nearly about its centre.

V. HEPATIC VEINS.

§ 1625. We may distinguish the *hepatic* veins (*V. hepaticæ*) into *large* and *small*.

The *small* are more numerous than the large. They empty into that portion of the ascending vena-cava, which ascends behind the liver, and are arranged irregularly in pairs one at the side of another. We number about twelve.

The *large* are much larger. They emerge from the posterior edge of the liver, much nearer its upper than its lower face, and empty into the anterior part of the vena-cava, directly below its passage through the square opening of the diaphragm.

There are usually two which open into the vena-cava near each other.

The *right* is smaller, and almost always a little deeper, and belongs entirely to the right lobe.

The *left* is much larger, especially in the fœtus, and divides directly below its insertion into the ascending vena-cava, into two trunks, of which the right belongs to the inner part of the right lobe, and the left to the left lobe only.

VI. INFERIOR DIAPHRAGMATIC VEINS.

§ 1626. The *inferior diaphragmatic* veins (*V. phrenicæ inferiores*) accompany the arteries of the same name, and empty either into the large hepatic veins or enter into the vena-cava, directly before it passes through the diaphragm.

CHAPTER VII.

SYSTEM OF THE VENA PORTA.

§ 1627. The *vena porta* (*V. portarum*,)* an extremely curious phenomena in the organism, is a small separate system, inclosed in the large, the roots of which arise from the intestinal canal, where it communicates with the system of the aorta by branches of the visceral and mesenteric veins, and which are distributed, like arteries in the liver,

* Walter, *De venâ port. exerc. anat.*, Leipsic, 1739. *Exerc. anat.*, vol. ii. 1740. Hœnlein, *Descriptio venæ portarum*, Frankfort, 1809.

where it unites by means of the hepatic veins (§ 1628) in the venous system of the body.

It is very unfrequently directly continuous with the venous system of the body, and then it does not ramify in the liver, but empties directly into the ascending vena-cava, of which it forms a ramification.* In this case the hepatic artery is larger than usual.

I. VENOUS PORTION.

§ 1628. The venous portion of the vena-porta is formed principally by three large trunks, the coronary vein of the stomach, the splenic and the mesenteric veins, which unite to produce the middle part or the trunk of the vena-porta.

I. CORONARY VEIN OF THE STOMACH.

§ 1629. The *coronary vein of the stomach* (*V. coronaria ventriculi superior*) corresponds to the artery of the same name. It is the smallest of the three branches. It empties from left to right, and from above downward into the trunk of the vena-porta, behind the piloric portion of the stomach. The constancy of its separation with the two other veins seems to be the cause why the cœliac artery divides so frequently into several trunks.

II. SPLENIC VEIN.

§ 1630. The *splenic* vein (*V. splenica*) not only takes up the blood from the spleen, the omentum, most of the stomach, the pancreas, and the duodenum, but receives also, shortly before it terminates, the last epiploic vein, and thus corresponds to the inferior mesenteric artery, so that consequently this latter is a subordinate trunk.

III. MESENTERIC VEIN.

§ 1631. The *mesenteric* vein (*V. mesenterica*, s. *mesaraica*) receives the veins of the small intestine, of the ascending and transverse colon. Consequently, it corresponds to the superior mesenteric artery. In the early periods of fœtal existence, it receives the omphalo-mesenteric vein, which arises from the umbilical vesicle and commonly disappears at the third month of pregnancy.

* These cases are extremely rare. We know of but four instances, only two of which are authentic. Lieutaud mentions one of the first class from Bauhin, (*Hist. anat. med.*, vol. i. p. 190), and Huber mentions another (*obs. anat.*, p. 31); but perhaps he means the trunk of the hepatic veins, which is probable. The authentic instances have been mentioned by Abernethy (*Ph. Tr.*, 1793, vol. i. p. 59-63), and Lawrence (*Med. ch. tr.*, vol. v. p. 174). These anomalies are very important in the history of the secretion of bile, and likewise for the theory of the primitive part of the vena-porta, and because they establish an analogy with the invertebral animals.

II. TRUNK AND ARTERIAL PORTION OF THE VENA-PORTA.

§ 1632. These last two branches, in uniting at a right angle, form the trunk of the vena-porta, the walls of which are thicker than those of its venous portion. This trunk proceeds obliquely upward to the right, behind the second curve of the duodenum, having in front the hepatic artery, the biliary ducts, the lymphatic glands, and the hepatic plexus, with which parts it is united by a common envelop, which comes from the peritoneum, the *capsule of Glisson* (*capsula Glissonii*). It ascends before the vena-cava, and is much larger than it. Near the right extremity of the transverse fissure of the liver, it divides at an acute angle into from two to five branches, of which the right is larger and shorter, goes directly to the right lobe of this gland, while the left is smaller and longer, proceeds transversely in the fissure, and enters into the left lobe.

The latter, in the fœtus, receives the umbilical vein, and gives off posteriorly the *venous canal*, which goes into the ascending vena-cava. These two vessels will be mentioned in the history of the fœtus.

In describing the liver, we shall mention the distribution of the arterial portion of the vena-porta.

SECTION IV.

PULMONARY ARTERY.

§ 1633. The *pulmonary* artery (*A. pulmonalis*, s. *vena arteriosa*) is generally a little smaller than the aorta, and arises from the summit or apex of the right ventricle, ascends to the left and backward, and presents a convexity upward and forward on the right, while it is concave downward and backward to the left. At its lower part it covers the commencement of the aorta in front, and in the rest of its course it proceeds on the left side of this artery, below its arch and on the left of its trunk. After passing through about two inches, it divides into a right and a left branch. From its bifurcation arises a round solid cord, a line thick and about four lines long, called the *arterial ligament* (*L. arteriosum*). This is the remains of a duct, the *arterial canal* or *canal of Botal* (*ductus arteriosus*, s. *Botallianus*), or the right root of the aorta, the changes of which we shall describe more minutely when giving the history of the fœtus. This cord ascends a little obliquely to the left, toward the commencement of the ascending aorta, and is attached to its anterior part so firmly that it cannot be separated without tearing. A cylinder of bone, more or less apparent, generally forms within it, even in young people, shortly after the canal is completely effaced, in accordance with this general law, that ossification marks a diminution of the vital activity in the organs.

The two branches separate from the trunk at a right angle, to go each to its corresponding lung.

The right branch proceeds transversely to the right, directly behind the aorta and the descending vena-cava, before the right bronchia. It is not only larger than the left, which depends on the greater size of the right lung, but it is also longer than it by the whole breadth of the aorta. It also penetrates more deeply into the fissure of the lung, and divides from above downward, before coming to the substance of the organ, into two branches, an upper, which is smaller, and the inferior, which is much larger.

The upper branch goes upward, and at the moment it enters the lung, divides again into two ramuscules, of which the lower is also the larger, while the upper bifurcates in turn.

The lower branch descends behind the superior pulmonary vein, to arrive at the middle and inferior lobes of the lung. It divides, opposite the middle lobe, into two branches, an anterior and superior, which bifurcates also before it enters the most internal part of the middle lobe, the other is much larger and lower, and, covered at first before by the middle branch of the right bronchia, goes to the lower lobe, and divides into three branches before it penetrates into it.

The *left branch* of the pulmonary artery is shorter and narrower, ascends a little on the left, goes toward the left lung, passes before the origin of the descending aorta, goes outward in the fissure of this lung, between its upper and its lower lobe, and divides into upper and lower branches. Those of its branches which arise the first, the posterior, are generally smaller than the anterior, which arise afterward; and those which ascend into the superior lobe are smaller but more numerous than those which descend into the lower. All generally bifurcate when they enter this organ.

The two branches of the pulmonary artery and all their ramifications are situated above and before the bronchia and their subdivisions.

§ 1634. The congenital anomalies of the pulmonary artery are,

1st. The total absence.

2nd. Its obliteration.

3rd. A great narrowness.

4th. Its insertion in the aorta: then it sometimes forms only one trunk, and sometimes its two principal branches arise from two separate places.

5th. Its insertion in the left ventricle.

6th. Its insertion in the two ventricles by the perforation of the base of the interventricular septum.

7th. The existence of two or four valves, instead of three.

8th. The permanence of the arterial canal.

9th. The insertion of this canal in the subclavian vein.

10th. Finally, the insertion of this canal in the right ventricle.

SECTION V.

PULMONARY VEINS.

§ 1635. The *pulmonary* veins (*V. pulmonales*, s. *arteriæ venosæ*) are usually destitute of valves, with some very rare exceptions.* They generally form on each side an upper and a lower trunk, which open at the four angles of the right auricle (§ 1308), and which, considered together, are a little smaller than the trunk of the pulmonary artery. The upper veins are a little larger than the lower, and are somewhat more distant from each other when they arrive at the auricle. Those of the same side are much nearer each other than those of the two sides. They are looser anteriorly than posteriorly, and are placed in front of the branches of the pulmonary artery and of the trachea. After proceeding a short distance, from four to six lines, each trunk, the inferior generally sooner than the superior, divides anew into at least two principal branches, viz. the upper into an upper and a lower branch, the lower into an anterior and a posterior branch, which commonly directly subdivide into two or more branches, before even penetrating into the fissure of the lung.

The right pulmonary veins are a little larger, but most generally much shorter than the left. They are always covered anteriorly by the descending vena-cava and also by the right auricle. The upper vein of this side comes from the upper and middle lobes of the right lung, from the first by its upper branch and by its lower branch from the second. The upper branch however usually receives one or more ramifications from the middle lobe, while the lower receives them only from the inferior lobe. The distribution of the pulmonary veins is then the opposite of that of the artery.

§ 1636. We not unfrequently find a greater† or less‡ number of trunks of the pulmonary veins, either from their division or their union. The first anomaly seems to be more common than the second. It does not always occur exactly in the same manner, and differs in quantity and quality. Most generally the number of trunks is increased by one only, there being five. In two cases now before us, the anomaly exists on the right side: the three trunks are situated one above another: the central trunk is much smaller than the other two, and is placed directly below the superior, being nearer to it than to the lower. We then observe in this only a greater development of the normal type.

* Kelch, (*Beytræge zur path. anat.*, Berlin, 1813, p. 81, No. 59) has found, before the orifice of one of the right pulmonary veins, a valve, which is very curious, as a repetition of what occurs normally in several reptiles.

† Meckel, *Mém. de Berlin*, 1750, p. 167.—Haller, *De part. corp. hum.*, f. i. f. ii. p. 123.—Portal, *Mém. de Paris*, 1771, *Hist.*, p. 74.—Sandifort, *Obs. anat. path.*, vol. iii. p. 41; vol. iv. p. 91.

‡ Loeseke, *Obs. anat.*, Berlin, 1751, p. 26.—Portal, *Mém. de Paris*, *loc. cit.*—Haller, *loc. cit.*—Pohl, *De venis*, Lcipsic, p. 11.—Sandifort, *Obs. anat. path.*, book iii. p. 18.

Less commonly we find a third trunk, which we have observed also on the left side, and which, proportionally smaller than the usual supernumerary vessel, arises by branches coming from the posterior part of the upper and lower lobes, is separated from the right superior pulmonary vein by the right branch of the pulmonary artery, and empties from above downward and from behind forward, into the posterior part of the right portion of the pulmonary auricle, almost opposite its centre.

Still more rarely also the number of pulmonary veins is increased by two, and becomes six; there are then sometimes three on each side, and sometimes four on one side and two on the other.* We regret that Sandifort did not state on which side the anomaly existed in the latter case.

The pulmonary veins seem to be diminished on the left side more frequently than on the right; at least this diminution has been observed on this side by Loeseke, Sandifort, and ourselves, while the veins on the right side were normal.

Other anomalies of the pulmonary veins, such as the termination of all or of one only, in the descending vena-cava or in the right auricle, are much more rare.

SECTION VI.

LYMPHATIC SYSTEM.

§ 1637. We have mentioned the general characters of the *lymphatic vessels*, in our General Anatomy: they accompany the two sections of the vascular system already described, particularly the veins, which they resemble much more than the arteries in their arrangement, and correspond to them so exactly, that their history is already partially given in that of the sanguineous system. The topography of the lymphatic system is generally stated without any regard to the difference of the two principal parts which compose it, the *vessels* and the *glands*. But the method adopted by some anatomists, among others by Cruikshank and Bichat, and which is to describe first the glands and then the vessels, is preferable. We also have adopted it, because, by insulating the history of the glands, we can not only present a more general picture of the distribution of the lymphatic vessels, but can form more exact ideas of the most essential particulars presented by the glands, in respect to their existence, number, situation, and size, in different parts of the body.

Authors are not agreed as to the order of describing the lymphatics. Some, as Sœmmerring and Portal, examine first those of the head, next those of the limbs, finally those of the thoracic and abdominal cavities and of the parts they contain. Others again, as Hewson and Cruik-

* Sandifort, *Obs. anat. path.*, book iii. p. 41, book iv. p. 91.

shank, regard only the position, and begin with the lymphatics of the lower limbs, then pass to those of the abdomen and chest, and terminate by those of the upper extremities and of the head. Many, of whom we shall mention Mascagni and Bichat, whose method resembles the preceding very much, describe the lymphatics according to the relations between them and the principal trunk; so that they divide them first into two large sections, comprising, first, those which communicate with the thoracic canal within the abdomen and the chest, second, those which open in the neck, either in this canal or directly into the subclavian and jugular veins.

Although the method of describing the lymphatic vessels of the lower limbs is preferable, because we can then commence with the most considerable part of the system, and particularly because it allows us to state beforehand the origin of the principal trunk, whence it is generally followed in treatises, it seems to us more convenient, in a complete treatise on anatomy, to examine these vessels in the order in which we have described the other sections of the vascular system; and consequently, as we take the history of the arteries as the base of that of the other vessels, to treat, first of the lymphatic vessels of the head and neck, then those of the upper extremities, next those of the viscera of the chest and of the abdomen, and lastly those of the lower extremities. By this method we finally arrive at the principal trunk, and the description follows the same course as the lymph does in the system.

CHAPTER I.

LYMPHATIC GLANDS.

I. LYMPHATIC GLANDS OF THE HEAD AND NECK.

I. LYMPHATIC GLANDS OF THE HEAD.

§ 1638. The *lymphatic glands of the head* are, proportionally speaking, very small and very few. They have not as yet been demonstrated strictly to exist within the skull, either in the brain or in the parietes. At least we cannot consider certain tumours, as those of scrofula, which are not unfrequently found in greater or less quantity in the substance or on the surface of the brain, as proving that lymphatic glands exist in this viscus;* for we have no proof that these tumours arise from enlarged glands and are not new formations.

We cannot assent to the opinion that the pituitary and pineal glands are lymphatic glands.

Those formations called *glands of Pacchioni* and the other analogous corpuscles which appear in the choroid plexuses are very different.

* Reil, *Memor. clin.*, vol. ii. f. 1, p. 39.

Those small bodies found in the carotid canal, and which are lymphatic glands, according to some anatomists, as Winterbottom* particularly, seem to us to be the upper ganglions of the great sympathetic nerve. We have formed this opinion after frequent examinations of them.

§ 1639. On the contrary there are evidently ymphatic glands on the outside of the head. They are much more rare in the cranial than in the facial portion. In fact, in the skull they exist only at the lower part, behind the ear; even there they are not constant and very small.

They are more numerous in the face. They are found also at its lower part, under the zygomatic arch, and around the parotid gland in all its extent. The superficial glands cover the outer face of this gland; the deep glands are situated on the buccinator muscle and behind the parotid gland. We also find very constantly within this gland one or more, which are small and almost, either alone or with those near them, the primitive seat of those tumors which are generally considered, but very wrongly, as developed in the substance this gland.†

The largest and most constant of these glands are situated along the lower edge of the lower maxillary bone, on the anterior part of the inferior belly of the digastricus muscle.

II. LYMPHATIC GLANDS OF THE NECK.

§ 1640. The lymphatic glands of the neck are distinguished into *superficial* and *deep*.

The *superficial* are smaller and less constant than the rest, and are found along the external jugular vein, between the platysma myoides and the sterno-cleido-mastoideus muscles.

The *deep* glands are much larger and more numerous; this region contains more than any other excepting the mesenteric.

There are none in the anterior part of the neck nor in the middle part of its lateral face, or we find at least only two or three of them which are small, which are not larger than a seed of hemp, and which are situated on the sides of the larynx, and between it and the hyoid bone. One or several of them are found on the mucous membrane of the trachea and of the esophagus imbedded in a great quantity of fat. They sometimes swell very much, and then may cause suffocation.‡

The lymphatic glands are small and inconstant also on the posterior part of the neck.

The largest and most numerous are those in the upper and in the lower part of the lateral faces of this region of the neck.

The *upper* and *anterior* (*G. concatenatæ*, s. *jugulares*) which are the largest, extend under the sterno-cleido-mastoideus muscle, from the

* *De vasis absorbentibus*, Edinburgh, 1781.
† Burns, *Surgical anatomy of the head and neck*.
‡ Burns, *loc. cit.*, p. 85, tab. 5.

mastoid process, along the carotid artery and the internal jugular vein, to the upper extremity of the cavity of the thorax. Some are placed outward, before the carotid artery, others inward, between this artery and the vertebral column. The most and the largest of these glands are found at the upper part of the neck, where the large vascular trunks divide.

The nearness of the carotid artery renders it possible to confound the tumours produced by their enlargement with an aneurism.* These tumours derange respiration and digestion because they compress the great sympathetic and pneumo-gastric nerves.

When the glands behind the large vessels swell, they usually embrace these trunks, and also the nerves, and are blended with them in a single mass.

The *inferior* and *posterior* are usually smaller. They are surrounded with a very loose cellular tissue; they occupy the triangular space between the sterno-cleido-mastoideus muscle, the clavicle, and the trapezius muscle, and frequently extend to the axillary glands, along the vessels of the shoulder.

II. LYMPHATIC GLANDS OF THE UPPER EXTREMITIES.

§ 1641. The lymphatic glands of the upper extremities are divided into the *brachial* and the *axillary*.

I. BRACHIAL GLANDS.

§ 1642. The *brachial* glands rarely exist below the humero-cubital articulation. We however sometimes find several on the course of the radial and ulnar vessels, but they are few and very small.

The glands of the elbow are situated on the anterior face of the arm, especially on that of the inner condyle of the humerus. They vary in number from one to four.

From the elbow to the axilla are from four to seven, placed successively on the inner and anterior side of the arm, along the superficial brachial artery.

II. AXILLARY GLANDS.

§ 1643. The axillary glands in number and size exceed the preceding: we number as many as twelve which surround the large trunks of the vessels. They exist principally between the serratus magnus and the pectoralis minor muscles and the internal part of the vascular trunks, to which they are sometimes very intimately united, but extend below the pectoralis major muscle and the clavicle.

* Burns, *loc. cit.*, p 81.

The deepest are the largest, and are covered by the pectoralis minor muscle.

III. LYMPHATIC GLANDS OF THE TRUNK.

§ 1644. The lymphatic glands of the trunk are divided into those of the thorax and those of the abdomen.

I. LYMPHATIC GLANDS OF THE THORAX.

§ 1645. The lymphatic glands of the thorax comprise the glands of the parietes of the thorax, those of the mediastina, and those of the lungs.

I. OF THE GLANDS OF THE PARIETES OF THE THORAX.

§ 1646. They are very small, and their number varies exceedingly. They are found in no determinate order, principally between the external and the internal intercostal muscles, particularly along the heads of the ribs, on the side of the vertebral column. Opposite these latter there are from six to ten on the anterior face, along the course of the internal mammary artery.

II. GLANDS OF THE MEDIASTINA.

§ 1647. The glands of the mediastina are distinguished into those of the anterior and those of the posterior mediastinum.

The glands of the posterior mediastinum descend along the esophagus and the aorta, and communicate outwardly with the posterior glands of the parietes of the chest. They are numerous but small. The largest are those which correspond to the central dorsal vertebræ. They not unfrequently swell and cause dysphagia, as Van Geuns has remarked.

Those of the anterior mediastinum are from eight to ten in number, and reascend along the anterior face of the pericardium from the diaphragm. They are rarely diseased, as Cruikshank has observed, and as we also have remarked.

III. BRONCHIAL GLANDS.

§ 1648. The *bronchial* glands (*G. bronchiales, pulmonicæ, Vesalianæ*)* are situated around the bronchi, but they penetrate, although gradually diminishing in size, in the substance of the lung along the ramifications of these channels. They are always numerous and large, and sometimes to an extraordinary degree. The largest usually exist

* Portal, *Sur la structure et sur les altérations des poumons, avec des remarques sur la nature de quelques symptomes de la phthisie;* in the *Mem. de Paris*, 1780.

before the bifurcation of the trachea between the two bronchi. In the adult they are more or less black. Sometimes this tint extends uniformly to every part; sometimes it exists in more or less broad and deep coloured patches. In infancy, on the contrary, the bronchial glands are reddish, like those of all other parts of the body. We have observed, that before becoming entirely black, their surfaces are covered to a greater or less extent with black spots, which probably depends on the mode in which the lymphatic vessels are distributed. Generally they do not begin to be coloured until the age of ten years, frequently not till twenty years. They do not all become dark at the same time, and their colour gradually deepens.

The extent and the degree of colouring immediately relate not only to the age of the subject, but also to the state of the lungs, and perhaps even to the nature of the air which is breathed, particularly to the quantity of carbon it contains; at least the bronchial glands are always proportionally larger and blacker in subjects affected with chronic disease of the lungs. They were even blacker than usual in a person affected with this disease, and who was in the habit of smoking.*

The black colouring matter is situated not only in the substance of the gland, but also in the fluids they contain, as it may be obtained by expression. The colouring substance seems to be pure carbon,† which Pearson thinks is not derived wholly from without.

Although these bodies are generally considered as true lymphatic glands, they are not admitted as such by all authors. Some, as Portal, distinguish the lymphatic glands of the lungs from the bronchial glands, or admit in the lung only a single species of glands, to which they refer the bronchial glands also; but, instead of regarding these bodies as lymphatic glands, consider them secretory organs. This is particularly the opinion of Senac.‡ This anatomist thinks, and in regard to the bronchial glands, Portal also, that they enclose a cavity communicating with the trachea by a canal, which may be easily demonstrated in a diseased state, by passing into it a bristle, and through which it is easy to cause the fluid they contain to pass into the trachea.

Not unfrequently, also, the most perfect similarity exists between the liquid contained in these glands, and that which lines the parietes of the trachea. Senac thinks that they do not act in the fœtus: according to Portal, their action continues during life.

According to Portal, the bronchial glands differ from the lymphatic glands of the lungs admitted by this anatomist to exist independently of them, in their situation, volume, and form, since the lymphatic glands are not placed like them below the ramifications of the trachea, but are dispersed irregularly in the substance of the lung, and are collected

* Pearson, *on the colouring matter of the black bronchial glands and on the black spots of the lungs*; in the *Phil. trans.*, 1825, plate ii. p. 166.

† Pearson, *loc. cit.*, p. 164.

‡ Senac, *Tr. du cœur*, vol. ii. p. 686.

particularly on the surface of this organ; they are also smaller, rounder, harder, and evidently receive lympathic vessels. They are also distinguished from them by their changes produced by disease, as the two kinds of pulmonary glands may be affected independent of each other.

We are, however, inclined to agree with those who make no distinction between the bronchial and the lymphatic glands of the lungs. All the characters assigned to them are purely accidental; the bronchial glands even frequently differ from each other in all these characters, as one may judge from the details we have previously mentioned.

In examining bronchial glands which are very much swelled and which manifestly contain a liquid, we have never discovered any canal going from these bodies to the trachea; and when these two organs communicate, it may depend on the enlargement or the morbid alteration of the glands, and their pressure upon the trachea; and farther, some persons have expectorated ossified portions of these glands.

In fact, our observations have shown that the bronchial glands are more subject to ossification than all others, within the substance of the lung, or around the bronchi.

II. GLANDS OF THE ABDOMEN.

§ 1649. The abdominal glands occupy principally the cavity of the abdomen. We find but seldom one or more of small size in the parietes of this cavity, for instance, above the umbilicus on the linea alba.*

The abdominal cavity of all the regions of the body contains the most lymphatic glands, because there the form and functions of the lymphatic system are most completely developed.

They are principally situated in the folds of the peritoneum which unite the abdominal viscera with each other, and with the parietes of the abdomen, and they may be divided into *mesenteric*, *gastric*, *cœliac* and *lumbar*.

I. MESENTERIC GLANDS.

§ 1650. The mesenteric are the largest and most numerous of all the abdominal lymphatic glands.†

They are divided into the *proper mesenteric* glands (*G. mesentericæ*) and the *mesocolic* glands (*G. mesocolicæ*).

The *proper mesenteric* glands are situated principally on the left and convex side of the superior mesenteric artery. They are incomparably more numerous and larger than the mesocolic glands. We usually number more than one hundred of them, sometimes even more than

* Mascagni, *loc. cit.*, p. 90.

† Werner and Feller (*Vasorum lacteorum atque lymphaticorum anatomico-physiologica descriptio*, Leipsic, tab. i), have figured some mesenteric glands and the lymphatic vessels of the small intestine. Barth, *De glandularum mesaraicarum inflammatione*, Halle, 1820.

twice that number, differences which depend only partially on the length of the intestinal canal. Those which correspond to the jejunum are more completely developed in every respect, than those which receive the lymphatics of the ileon. They are rarely less than two inches from the intestine. From this point to the base of the mesentery, they gradually enlarge and approach each other, so that sometimes many are blended in one mass, resembling what is seen in many mammalia, where they are termed the *pancreas aselli.*

These are principally the glands which are swelled in scrofulous patients.

The *mesocolic* glands are much smaller and fewer than the preceding. There are seldom more than thirty; sometimes there are only twenty; in some rare cases there are fifty. They are situated nearer the intestine than the mesenteric glands, and sometimes rest directly upon it. There are still more in the transverse mesocolon, at the lower part of the ascending colon and in the sigmoid portion of the descending colon, than in the other regions.

These glands are rarely swelled even when the preceding are so.

II. GASTRO-EPIPLOIC GLANDS.

§ 1651. The *gastro-epiploic* glands (*G. stomacho-epiploœ*) are situated along the large (*G. ventriculi inferiores*) and the small (*G. ventriculi superiores*) curves of the stomach. They are small and few, and not more than four or five to each curve.

III. CELIAC GLANDS.

§ 1652. Under the term *celiac* glands we may include, as Bichat does, the *hepatic,* the *pancreatic,* and the *splenic* glands. They surround a greater or less portion of the trunk of the vena porta, the splenic vessels, and the trunk of the celiac and superior mesenteric arteries.

IV. LUMBAR GLANDS.

§ 1653. The *lumbar* glands (*G. lumbares*) are generally very numerous and very large, and surround, forward and on the two sides, the abdominal aorta and the ascending vena-cava, and also the renal vessels. The anterior are larger than the lateral, which are placed on the sides of the bodies of the vertebræ, and before their transverse processes.

IV. LYMPHATIC GLANDS OF THE LOWER EXTREMITIES.

§ 1654. The lymphatic glands of the lower extremities may be divided into the *crural* and *pelvic.*

I. CRURAL GLANDS.

§ 1655. Lymphatic glands are rarely found below the femoro-tibial articulation. Cruikshank* and Hunter have never seen them. Sometimes, although very rarely, there exists on the anterior face of the leg, between the tibia and the fibula, a little below the middle of the limb† or higher, near the upper extremity of the interosseous membrane, a small gland, which we have once seen double; this is called the *anterior tibial* gland (*G. tibialis antica*). The *popliteal* glands (*G. popliteæ*) are larger than the tibial, although they are very small. They are rarely more than three or four in number, and are situated deeply in the fat, and surround the popliteal vessels.

II. PELVIC GLANDS.

§ 1656. The *pelvic* glands (*G. pelvianæ*) are divided into the *inguinal*, the *external iliac* or *hypogastric* and the *sacral* glands.

I. INGUINAL GLANDS.

§ 1657. The *inguinal* glands (*G. inguinales*), are the largest in the body except the mesenteric. They are divided into *superficial* and *deep*.

The *superficial* vary in number from six to thirteen, and are situated directly under the skin, between it and the fascia-lata aponeurosis. They sometimes commence on the internal face of the middle of the thigh. The upper, which are constant, are always closer to each other than the lower; they surround the upper part of the internal cutaneous vein of the thigh and extend to the symphysis pubis.

The *deep* are fewer in number, and vary from three to seven. They are placed below the crural aponeurosis, between the adductor, the sartorius, and the iliacus muscles, and surround the superficial crural arch.

The deep glands are not so constant as the superficial.

II. EXTERNAL ILIAC GLANDS.

§ 1658. The *external iliac* glands (*G. iliacæ externæ*) are six, eight, or ten in number, and extend along the external iliac vessels, from the crural arch to the beginning of the lumbar region, where they are continuous with the lumbar glands.

* *Loc. cit.*, p. 117.
† Hewson, *loc. cit.*, p. 27.

III. HYPOGASTRIC GLANDS.

§ 1659. The *hypogastric* or *internal iliac* glands (*G. hypogastricæ*, s. *iliacæ internæ*) also vary in number; but generally they are more numerous than the external. These glands accompany the internal iliac vessels.

IV. SACRAL GLANDS.

§ 1660. The *sacral* glands (*G. sacrales*) are situated between the rectum and the sacrum. They are united laterally with the preceding and above with the mesocolic glands.

CHAPTER II.

LYMPHATIC VESSELS.

§ 1661. We may divide the lymphatic vessels of all parts of the body into *superficial* and *deep*. We shall describe them in the same order as we have the glands.

ARTICLE FIRST.

LYMPHATIC VESSELS OF THE HEAD AND THE NECK.

I. SUPERFICIAL LYMPHATIC VESSELS.

§ 1662. The *superficial lymphatics of the head* proceed under the skin. They are divided into those of the skull and those of the face.

The *superficial lymphatics of the skull* unite in from four to eight trunks, which form two fasciculi, an anterior and a posterior. The anterior descend along the temporal arteries, the posterior along the occipital artery. The first pass through some of the superficial zygomatic glands, the latter those which exist behind the ear. Both unite with the superficial lymphatics of the neck.

The *superficial lymphatics of the face* are more numerous than those of the skull, because there is more of cellular tissue in the face. They descend along the vessels of the face, pass through, partly, the glands situated on the buccinator muscles, but principally and constantly cross those which occupy the lower edge of the maxillary bone and the upper part of the neck.

In this place the superficial lymphatics of the skull and face anastomose frequently together, and with the deep lymphatic vessels of the head; descend, in three or four trunks, some on the sides of the tra-

chea, others on the posterior part of the neck, along the internal and the external jugular veins, receive the lymphatic vessels of the thyroid gland and of the muscles of the neck, and pass over the inferior lateral glands.

II. DEEP LYMPHATIC VESSELS.

§ 1663. The *deep lymphatic vessels of the head* are also divided into those of the skull and those of the face.

The *deep lymphatics of the skull* have not been pursued with clearness and certainty into the substance of the brain, but only into its membranes. They are seen here and there, especially when serum is effused upon the surface of the brain, both in the outer face of this organ, in the pia-mater and the arachnoid membrane, and likewise in the dura-mater, where they follow the course of the blood-vessels. Their trunks descend from the skull, along the internal carotid and vertebral arteries and the internal jugular vein, and unite with the superficial lymphatics of the skull and head, some in the superior, others in the inferior cervical glands (§ 1662).

The *deep lymphatics of the face*, arise from the muscles of this region, from the nasal fossæ, and from the buccal cavity, penetrate into the superior cervical glands, and unite, both within these glands and after emerging from them, with those which arise from the trachea and pharynx.

§ 1664. The trunks of all the superficial and the deep lymphatics of the head and neck, pass through the inferior cervical glands which they unite, anastomose very frequently with each other and with some vessels which come from the upper extremities and from the cavity of the thorax, which arrive at the lowest of these glands, and unite in one of several trunks which open into the upper part of the thoracic canal, either directly into the angle of union of the jugular and subclavian veins, or finally into one of these last two, and then into the internal jugular, more frequently than into the subclavian vein.

ARTICLE SECOND.

LYMPHATIC VESSELS OF THE UPPER EXTREMITIES.

§ 1665. We must consider, at the same time with the lymphatic vessels of the upper extremities, particularly the superficial, the superficial lymphatics of the dorsal face of the trunk, and of the middle part of its anterior face: for all these vessels terminate in the axillary glands. This arrangement is demonstrated not only by dissection, but by the swelling of the axillary glands, when the vessels remote from these regions have been irritated; as when, for instance, a blister has been applied to the epigastric region.

I. SUPERFICIAL LYMPHATIC VESSELS.

I. SUPERFICIAL LYMPHATIC VESSELS OF THE DORSAL FACE OF THE TRUNK.

§ 1666. The superficial lymphatic vessels of all the dorsal face of the trunk, from the neck to the lumbar region, terminate in the axillary glands.

The superior, which arise from the neck, descend on the trapezius muscle, pierce the deltoides, and in this place, before arriving at the axillary glands, receive those which arise from the skin of the shoulder.

The middle and the inferior proceed transversely upward on the trapezius muscle, pass through this muscle, arrive outward, between it and the teres major muscles, and terminate in the axillary glands.

II. SUPERFICIAL LYMPHATIC VESSELS OF THE LATERAL AND ANTERIOR FACES OF THE CENTRAL REGION OF THE TRUNK.

§ 1667. These vessels arise from the chest, and from that portion of the abdomen above the umbilicus.

The *lateral*, which extend lower than the others, penetrate through the obliquus externus abdominis, and the serratus magnus muscles.

The *anterior* and *superior*, the highest of which arise from the lower part of the neck, proceed on the pectoralis major muscle, turn on the lower edge of this muscle, and go backward to the axillary glands.

Some of these vessels, the deepest, pass through the rectus abdominis muscle in some subjects, into the internal lymphatic vessels of the thorax. Others, which are situated above, proceed through the deep muscles of the parietes of the thorax, and anastomose with the intercostal lymphatics.

These lymphatic vessels frequently communicate with the inferior, which descend from the anterior face of the abdomen to the inguinal glands.

II. SUPERFICIAL LYMPHATIC VESSELS OF THE UPPER EXTREMITIES.

§ 1668. The superficial lymphatic vessels of the upper extremities, are distinguished into *external* and *internal*.

The *external* commence on the dorsal face of the fingers, proceed first on their sides, follow the course of the cutaneous vessels on the back of the hand, and ramify in this place and in the fore-arm, on the external and posterior faces of which they principally ascend, and here they are farther increased by the lymphatic vessels which arise from this region. They proceed gradually forward and inward, so that near the humero-cubital articulation, they are situated entirely on the inner face of the limb.

The *internal* arise from the internal face of the hand, also proceed along the lateral faces of the fingers, attended by the palmar vessels, anastomose in this place with the dorsal lymphatic vessels, and unite in the hollow of the hand in three or four trunks, two of which are formed by the lymphatic vessels of the thumb and little finger, and a third and sometimes a fourth is formed by those of the other three fingers. They then ascend on the inner face of the fore-arm, and there receive several of the lymphatic vessels from the integuments of this region. All, or at least most of them, pass through the glands of the elbow, and unite at this point and higher with the external. The largest trunks which result from this union, and which are the fewest, ascend along the inner face of the arm, and following the course of the large blood-vessels, terminate principally in the axillary glands.

Some of them, but very few, attend the cephalic vein between the deltoides and pectoralis major muscles, and go to the inferior cervical glands.

II. DEEP LYMPHATIC VESSELS OF THE UPPER EXTREMITIES.

§ 1669. The deep lymphatics of the upper extremities accompany the deep vessels so exactly, that it is useless to describe them, and they may be known well enough by the terms *radial, ulnar, and interosseous* (*vasa l. radialia, ulnaria et interossea*). They proceed principally on the inside of the hand, the fore-arm, and the arm, frequently anastomose with the superficial, and receive at the upper part of the arm the small trunks which come from the pectoral muscles.

These deep lymphatic vessels partly penetrate into the glands which are rarely formed in the fore-arm, and all terminate in those of the axilla.

III. TERMINATION OF THE LYMPHATICS OF THE UPPER EXTREMITIES AND TRUNK.

§ 1670. The lymphatic vessels hitherto described, and which pass through the axillary glands, unite in larger trunks within these glands and in the spaces between them, and are finally reduced to four or five in number, which surround the subclavian artery. They unite anew into two or three large trunks, in the place where this artery comes to the upper part of the chest; these ascend behind the subclavius muscle, above the subclavian vein, and open directly into it, either alone or united with the deep lymphatics of the trunk, the head, and even also those of the left side, with those of the lower extremity.

ARTICLE THIRD.

DEEP LYMPHATIC VESSELS OF THE THORAX.

§ 1671. It is most convenient to describe the lymphatic vessels of the abdomen separately from those of the chest, and to place the history of the former after that of the lymphatic vessels of the lower extremities.

We distinguish the deep lymphatics of the chest into those of the parietes and those of the organs it contains.

I. LYMPHATICS OF THE PARIETES OF THE THORAX.

§ 1672. The deep lymphatics of the parietes of the thorax are divided into *lateral, posterior*, and *anterior*.

I. LATERAL AND POSTERIOR LYMPHATIC VESSELS.

§ 1673. The *lateral* and *posterior* lymphatics (*Vasa l. intercostalia posteriora*) arise from all the muscles which surround the chest and contribute to form its parieties, also from the pleura, and reunite with the posterior intercostal trunks, which proceed along the intercostal vessels. They also receive on the side of the vertebral column the lymphatic vessels which come from the muscles of the back and from the vertebral canal, pass through the lateral glands of the vertebral column, frequently anastomose and communicate, particularly the upper, with the glands of the lung, principally follow a more or less descending direction, and gradually terminate in the thoracic canal.

II. ANTERIOR LYMPHATIC VESSELS.

§ 1674. The *anterior lymphatics of the parietes of the thorax*, or the *internal mammary lymphatic vessels* (*Vasa l. thoracica profunda antica*, s. *mammaria interna*), arise by their deepest branches from the upper and anterior part of the abdominal muscles and the diaphragm, penetrate into the chest, below the xiphoid cartilage, proceed on both sides of the sternum and along its posterior face, pass through the glands in this place, and receive, on each side, the *anterior intercostal lymphatic* vessels (*Vasa l. intercostalia antica*).

Those of the left side rarely unite in two trunks, usually in one, which ascends obliquely before the left subclavian vein, passes through the inferior cervical glands, afterward descends on leaving this point, and opens into the thoracic canal, more rarely into the venous system.

Those of the right side commonly empty into the right subclavian and internal jugular veins; but they also sometimes unite previously with the lymphatics of the head and of the upper extremities.

II. LYMPHATIC VESSELS OF THE THORACIC VISCERA.

§ 1675. The lymphatic vessels of the thoracic viscera are divided into those of the lungs, the pericardium, the thymus gland, and the heart.

I. LYMPHATIC VESSELS OF THE LUNGS.

§ 1676. The *superficial* lymphatic vessels of the lungs arise on the surface of this organ from the pulmonary portion of the pleura, and form, on the lungs, a very complex network, with irregular meshes, which corresponds to the lobes of the viscus. Some of the trunks formed penetrate within the fissures of the lobes, and within the glands at the base of these spaces; others proceed along the internal face of the lungs and empty into the bronchial glands.

The *deep* lymphatics of the lung arise from the substance of the viscus, anastomose very frequently with the superficial, proceed along the ramifications of the trachea and the pulmonary vessels, also enter into the bronchial glands, anastomose with the superficial vessels within them, and then proceed along the air-passages.

After leaving the bifurcation of the trachea, the lymphatic vessels which come from the bronchial glands, soon unite in three or four trunks, of which only one exists on the right and the others belong to the left side.

Both pass through some inconstant glands situated before and on the sides of the trachea, go behind the internal jugular vein on their side, and empty immediately, or in connection with the lymphatic vessels of the neck and upper extremities, into this or into the subclavian vein.

The pulmonary lymphatic vessels receive, on the trachea, those of the pericardium and of the thymus gland, which ascend into the anterior mediastinum after passing through some glands placed before the aorta and the vena-cava.

II. LYMPHATIC VESSELS OF THE HEART.

§ 1677. The *lymphatic vessels of the heart* principally accompany the large vessels of this organ, leave the pericardium and ascend on the aorta and the pulmonary artery, pass through the glands on the former of these two vessels, and unite, on one side, with the lymphatic vessels of the lung, the thymus gland, and the pericardium, and on the other, usually empty, by several small trunks, either into the thoracic canal or directly into the left jugular and left subclavian veins.

ARTICLE FOURTH.

LYMPHATICS OF THE LOWER EXTREMITIES, AND SUPERFICIAL LYMPHATICS OF THE LOWER PORTION OF THE TRUNK AND OF THE EXTERNAL GENITAL ORGANS.

§ 1678. The most proper mode of describing the lymphatic vessels of the lower extremities is to pursue the order adopted for the upper extremities and for the superficial vessels of the neck and back, and connect their description with that of the superficial lymphatics of the lower portion of the trunk and of the external genital organs.

I. LYMPHATIC VESSELS OF THE LOWER PORTION OF THE TRUNK.

§ 1679. The superficial lymphatic vessels of the lower portion of the trunk arise from the skin and the cellular substance of that portion of the abdomen below the umbilicus, the lumbar region, the haunches, and the perineum frequently anastomose with each other or with the superficial vessels of the lower extremities, communicate also, at least the former, with the superficial lymphatics of the upper part of the trunk, and empty into the inguinal glands.

II. SUPERIOR LYMPHATIC VESSELS OF THE EXTERNAL GENITAL ORGANS.

§ 1680. The superficial lymphatic vessels of the external genital organs arise in the male from the scrotum and penis, in the female from the labia pudenda and clitoris. Those of the penis and clitoris proceed, in two or three trunks, along the sides and back of these parts. They anastomose frequently with the superficial lymphatics of the thigh, and empty into the inguinal glands.

III. LYMPHATIC VESSELS OF THE LOWER EXTREMITIES.

I. SUPERFICIAL LYMPHATIC VESSELS.

§ 1681. The *superficial* lymphatic vessels of the lower extremities are situated between the *fascia-lata* and the skin, and are divided into *anterior*, which correspond to those of the anterior face of the fore-arm, and *posterior*, which are repetitions of those in the hollow of the hand and of the inner side of the fore-arm. The *anterior* arise from the back and sides of the toes, and from the back of the foot, ascend on the anterior and lateral faces of the leg, are finally placed on the inside of this limb, and then ascend along the internal face of the thigh.

The *posterior* come from the sole of the foot, ascend along the posterior face of the leg, and anastomose frequently with the anterior.

The largest and fewest trunks which are formed by the union of both, ascend along the internal and anterior part of the th gh, and empty at the summit into the superficial inguinal glands.

The superficial lymphatic vessels of the thigh proceed principally along its internal and its anterior face. Even those which arise from its posterior face take the same direction. They anastomose with those of the leg, and go to the inguinal glands.

II. DEEP LYMPHATIC VESSELS.

§ 1682. The deep lymphatics of the lower extremities are fewer than the preceding, and also differ in their situation being placed below the aponeurosis.

They form four fasciculi, each of which unites in one or two small trunks, which proceed along the three arteries of the thigh and the external saphena vein. They arise from the same parts as those to which these arteries proceed, and from whence this vein arises, and all unite in the ham, in the popliteal glands.

The anterior tibial lymphatic vessels sometimes pass through the anterior tibial glands (§ 1655), which are not constant.

From three to six trunks come from the popliteal glands which are united by these vessels: these trunks ascend along the superficial popliteal and crural vessels which they surround, and receive principally the deep crural lymphatic vessels, which accompany the deep blood-vessels of the thigh.

These deep crural lymphatic vessels, which anastomose frequently with the superficial, enter, some into the deep, others into the superficial inguinal glands. Some pass before these glands, to the inferior iliac glands.

§ 1683. The superior deep lymphatic vessels which arise from the adductor and extensor muscles, and those which rotate the thigh outward, and also from those of the perineum, accompany the obturator, ischiatic, and gluteal vessels, and terminate in the hypogastric and sacral glands.

ARTICLE FIFTH.

ABDOMINAL LMYPHATIC VESSELS.

§ 1684. The abdominal lymphatic vessels divide like the thoracic, into those of the abdominal parieties, and those of the organs containe in the cavity of the abdomen.

I. OF THE LYMPHATIC VESSELS OF THE ABDOMINAL PARIETES.

§ 1685. The lymphatic vessels of the abdominal parietes are divided into the *anterior*, the *lateral*, the *posterior*, and the *inferior*.

The *anterior* arise from the skin, from the aponeurosis of the abdominal muscles and from the rectus muscle which they perforate, accompany the epigastric artery, and terminate in the external iliac glands.

The *lateral* come from the integuments, and from the lateral parts of the abdominal muscles, perforate the broad muscles in this region, proceed along the crest of the ilium, and arrive at the external iliac glands.

The *posterior* have their origin in the skin of the lumbar region, the quadratus lumborum muscle, the posterior part of the abdominal muscles, and the spinal canal, go inward with the lumbar arteries which they accompany, extend to the vertebral column, penetrate into its lateral glands, and anastomose frequently with those of the side opposite, on the anterior face of the vertebral column, thus giving rise to the *lumbar plexus*.

The *inferior* are distinguished into *lateral* and *posterior*. The *lateral* arise from the iliac bones, from the iliacus muscle, and from the levator ani muscle. They pass below the psoas magnus muscle, and go to the external and the internal iliac glands.

The *posterior* arise from the pyramidalis muscle, from the sciatic plexus, from the sacrum, and from the cavity of this bone. They terminate in the lumbar and the internal iliac glands.

All these lymphatics anastomose either at their origins, or within the glands which they enter.

II. LYMPHATIC VESSELS OF THE ABDOMINAL VISCERA.

§ 1686. The lymphatic vessels of the abdominal viscera are distinguished into the deep lymphatic vessels of the genital and urinary organs, and into those of the digestive apparatus.

I. DEEP LYMPHATIC VESSELS OF THE GENITAL AND URINARY ORGANS.

§ 1687. The superficial lymphatic vessels of the genital organs have already been described.

Among the deep, those of the penis and clitoris enter the pelvis along the deep blood vessels of those parts, go to the internal pelvic glands, and anastomose with the inferior lymphatic vessels of the parietes of the abdomen.

The lymphatics of the testicle, which are very numerous and proportionally very large, form two layers, of which the external arises from the tunica vaginalis, and the deep or internal from the substance of the gland. They unite in from eight to twelve trunks, ascend along

the spermatic cord to the inguinal ring, and go to the lumbar glands, following the course of the spermatic artery.

The lymphatics of the prostate gland and vesiculæ seminales anastomose with those of the bladder.

The lymphatics of the vagina and lower part of the uterus penetrate into the internal pelvic glands ; a part of those of the lower part of the vagina accompany the round ligament of the uterus, pass through the inguinal ring, and anastomose with those of the uterus. Those of the upper part of this latter organ which unite with those of the ovary, follow the course of the spermatic vessels, and terminate in the lumbar glands, like the corresponding vessels in the male.

§ 1688. Among the lymphatic vessels of the urinary passages, those of the bladder go to the internal pelvic glands.

Those of the ureters enter the external pelvic and lumbar glands, and anastomose with those of the bladder and kidneys.

Those of the kidneys arise from the outside and inside of these organs. The former, or the *superficial*, unite with the second or the *deep*, either directly or after forming several small trunks. The first is true of the internal, and the second of those which arise from the rest of the surface of the kidneys.

The trunks formed by the union of the deep lymphatic vessels leave the renal fissure, accompany the renal vessels, anastomose frequently with those of the genital organs and of the capsulæ renales, and empty into the lumbar glands. Several of them open into the thoracic canal.

Those of the renal capsules unite, some with those of the kidneys, others with those of the liver, the spleen, and the intestinal canal.

II. LYMPHATIC VESSELS OF THE DIGESTIVE ORGANS.

§ 1689. The lymphatic vessels of the digestive organs are divided into those of the intestinal canal, those of the stomach and the omenta, the liver, the spleen, and of the pancreas. They are also called the *lacteal* or *chyliferous vessels*, on account of the fluid they carry at the time of digestion. If however, we except at most the final branches, we ought not to distinguish between the lymphatic vessels which take up the chyle from the intestinal cavity and those which receive the lymph in the substance of the organ, since both fluids follow precisely the same direction.

I. LYMPHATIC VESSELS OF THE INTESTINAL CANAL.

§ 1690. The lymphatic vessels of the intestinal canal (*V. l. intestinalia*), like the glands, are much more numerous in the small than in the large intestine : there are more also in the duodenum and the jejunum than in the ileon. They may be distinguished into *superficial* and *deep*.

The *superficial* arise from the peritoneum, between this membrane and the muscular tunic, and from the latter. They proceed along the intestine, and frequently anastomose together above and below.

The *deep* arise from the vascular and villous tunic, principally receive the radicles which absorb the chyle, follow a transverse direction, surround the intestinal canal like rings, and anastomose with the superficial, both on the intestine and between the folds of the mesentery. All unite in small trunks, which, two, three, or four in number, proceed between the folds of the mesentery, follow the course of the intestinal vessels, pass through the series of the mesenteric glands, gradually enlarge as they proceed, but become fewer in the same proportion, and anastomose near the pancreas with the lymphatic vessels of this organ, the spleen, and the liver, and concur with the latter to form one of the great roots of the thoracic canal. The lymphatic vessels of the descending colon however do not unite to produce the small trunks. They empty very low into the lumbar and sacral glands.

II. LYMPHATIC VESSELS OF THE STOMACH AND OF THE OMENTA.

§ 1691. The lymphatic vessels of the stomach and of the omenta, or the *gastro-epiploic* (*Vasa l. gastro-epiploica*), also form a superficial and a deep layer. We may divide them, in respect to their course, into three fasciculi, which follow the course of the principal blood-vessels of the stomach.

Those of the left side, which arise from the base of the stomach, accompany the short vessels and go to the left, where they anastomose with those of the spleen.

The middle superior arise from the upper part of the rest of the surface of the stomach, go upward and to the left, pass through the glands of the small curvature of the stomach, and reunite at the left orifice of this viscus. Thence they go to the right, pass through the other glands, and anastomose under the liver with the inferior lymphatic vessels of this gland.

The middle inferior, which come from the rest of the surface of the stomach and from the large epiploon, proceed, in company with the blood-vessels, along the large curvature of the stomach, pass through the glands in this place, go towards the right side, partially reunite with the middle superior, and go downward behind the pancreas to unite around the cœliac and superior mesenteric arteries with the intestinal lymphatic vessels, with which they form one of the principal roots of the thoracic canal.

III. LYMPHATIC VESSELS OF THE SPLEEN AND THE PANCREAS.

§ 1692. Among the lymphatic vessels of the spleen and pancreas (*V. l. splenico-pancreatica*), the *superficial* vessels of the spleen arise from its peritoneal coat, and the *deep* vessels from its substance. The

former are reflected around the edge of the spleen, and all, after reuniting in its fissure, leave this cavity, go to the right, accompany the splenic vessels, and anastomose there with the other lymphatics of the digestive organs.

Those of the pancreas soon join those of the spleen and the middle inferior lymphatics of the stomach.

IV. LYMPHATIC VESSELS OF THE LIVER.

§ 1693. The lymphatic vessels of the liver (*V. l. hepatica*)* are extremely numerous, and seem to differ from most of the others by the fewness and smallness of their valves. In fact we can generally succeed in injecting them from the trunks, and when injected their course is much more uniform than the others. They may be distinguished into *superficial* and *deep*.

a. Superficial lymphatic vessels.

§ 1694. The *superficial lymphatic vessels of the liver*† may in turn be divided into those of the upper and those of the lower face.

1. Lymphatic vessels of the upper face of the liver.

§ 1695. The superficial lymphatic vessels of the upper face of the liver form several fasciculi, which vary in number from four to ten.

Those of the middle fasciculus, which is the largest, arise from the middle region of the right lobe, partly also from the left lobe. They reunite in six or eight trunks, which enter into the suspensory ligament of the liver, and pass into the chest, between the diaphragm and the xiphoid cartilage of the sternum. There they reunite with the lymphatic vessels of the upper face of the diaphragm, form one or two trunks, enter into the mediastinum, through which they pass from below upward, receiving several lymphatics from the pericardium, the thymus gland, and from the anterior wall of the thorax, and usually open into the left thoracic canal, just before it terminates. They frequently also empty partially or wholly into that of the right side. Sometimes several trunks of this fasciculus do not unite with the rest, but go to the left, pass into the coronary ligament of the liver, between the diaphragm and the left lobe, join the other fasciculi of the hepatic lymphatic vessels, and empty into the lower part of the thoracic canal, within the abdominal cavity or in the chest.

The second fasciculus arises from most of the surface of the right lobe, sometimes in a greater and sometimes a less extent. The trunks reach the right ligament of the liver, pass through the diaphragm in

* Schmiedel, *De habitu naturali venarum lymphaticarum in hepate*, Erlangen, 1747.

† Werner and Feller, *De vasis hepatis superficialibus*, p. 34-44.— *Loc. cit.* tables ii. iii. iv.

this place, proceed from below upward, and from behind forward on the convex face of this muscle, along its costal edge, and empty into the trunks of the first fasciculus. Others, which are smaller, go backward, and open into the lower part of the thoracic canal, anastomosing with the inferior diaphragmatic lymphatics.

The third fasciculus arises from most of the surface of the left lobe. Its trunks go to the left triangular ligament of the liver, separate in this place, unite with the upper lymphatic vessels of the stomach, and open into the lower part of the thoracic canal, which is still within the abdominal cavity.

2. Lymphatic vessels of the lower face of the liver.

§ 1696. The superficial lymphatic vessels of the lower face of the liver generally form fewer fasciculi than those of the upper face. Those too on the right side generally unite with those on the left. All anastomose with the superficial and the deep lymphatic vessels of the upper face, and give origin to small trunks. The latter approximate each other near the vena portæ, descend along the course of the hepatic blood-vessels, and reunite with those of the intestinal canal.

Other superficial lymphatic vessels of the liver enter into the substance of this gland but do not reunite to those described, and empty into the deep lymphatic vessels.

b. Deep Lymphatic vessels.

§ 1697. The deep lymphatic vessels of the liver are much more numerous than the superficial, and accompany the hepatic blood-vessels and the biliary canals, emerge with the latter through the fissure of the vena portæ, and unite in the small epiploon, with the superior lymphatics of the stomach, emptying into the glands of this part, and reunite with the superficial lymphatics of the lower face of the liver, the lower lymphatic vessels of the stomach, those of the spleen and pancreas, descend along the hepatic vessels, anastomose at the base of the mesentery with the intestinal lymphatics, and form, in connection with them, one of the principal roots of the thoracic canal, the middle.

ARTICLE SIXTH.

OF THE THORACIC CANAL.*

§ 1698. All the lymphatic vessels open into the venous system of the body in two different places, at the union of the right and left in-

* J. A. Leitersperger, *Præs.* Salzmann, *Enchiresis nova, qua ductus thoracicus una cum receptacula chyli in quovis subjecto humano demonstrari potest*, Strasburg, 1711.—J. S. Henninger, *De mesenterio*, Strasburg, 1714.—C. P. Wium, *De vitiis*

ternal jugular and subclavian veins. Most of them empty into the left side; this is the case with the lymphatic vessels of the left portions of the head and neck, those of the left upper extremity, the superficial vessels of the left portion of the trunk, all the deep lymphatic vessels of the chest, except those which arise from the right lung, those from the right portion of the heart and of the thyroid gland, generally also those of the right portion of the diaphragm, and of the right portion of the anterior wall of the chest, finally with those of the lower extremity and of the abdomen, except some which arise from the right half of the upper face of the liver.

On the contrary, the lymphatic vessels of the right portion of the head and neck, those of the right upper extremity, those of the right portion of the diaphragm, partially or wholly, and those of the right portion of the liver, go to the right side.

Those of the lower extremities, the intestinal canal, the stomach, and the spleen, most of those of the liver and the intercostal lymphatic vessels, do not empty directly into the venous system; but they always open * one after another, into the *left thoracic canal* (*ductus thoracicus sinister*), which is formed by their union. Those of the other organs, on the contrary, which we have described, do not empty except into the upper part of this canal, and in part also open directly into the internal jugular and subclavian veins.

I. LEFT THORACIC CANAL.

§ 1699. The lacteal vessels and the lymphatic vessels of the lower extremities unite towards the first or the second lumbar vertebra,

mentorum et chyli., Copenhagen, 1717.—A. F. Walther, *Obs. de ductu hepatico bipartito, vena bronchiali sinistra et inferiore, arteria hepatica, superioris mesaraicæ sobole*, Leipsic, 1731.—J. C. Bohl, *De via lactea*, Konisburg, 1741.—C. M. Bussmann, *Præs.* Haller, *De ductu thoracico*, Gottingen, 1741.—F. J. Narcissus, *De generatione et receptaculis chyli*, Leyden, 1742.—C. H. Velse, *De mutuo intestinorum ingressu et aliis machinæ humanæ extraordinariis*, Leyden, 1742.—A. Portal, *Sur la struct. du canal thoracique et sur celle du reservoir du chyle*; *in the Mem. de Paris*, 1770, p. 393-402.—Sabatier, *Remarques sur le canal thoracique de l'homme*; *in the Mem. de Paris*, 1780, p. 693.

* Lippi, demonstrator at the hospital, Santa-Maria-Nuova at Florence, seeking some unknown channel by which nature conducted the white fluids into the sanguineous system, without carrying them by a long route to the thoracic canal, has found a large lymphatic trunk, which emptied into the ascending vena cava, at about the third lumbar vertebra, after passing from above downward, between the trunks of this vein, into which it opened in a direction opposite to that of the course of the blood. The orifice had a kind of valve. Some days after, the same anatomist remarked four distinct trunks which opened, one into the primitive iliac vein, and others into the vena cava. Having injected an inflamed liver, he saw some lymphatics of its triangular ligament entering into the ramifications of the vena portæ. As he first injected the right side, Lippi undertook to do the same on the left. Having pushed the mercury into the external iliac lymphatics, whence this metal arrived at those situated behind the vertebral column, in the lumbar region, he saw several lymphatics on the left side, entering into the vena cava, some passing above, others below the aorta, he also saw some emptying into the splenic and mesenteric veins: Lippi believed that he could distinguish the lacteals which open into the thoracic canal, from those of the external face of the peritoneum, which empty in great part into the veins with those which arise from the lower extremity. F. T.

sometimes also between the second and the third, or even upon the twelfth dorsal vertebra, between the internal pillars of the diaphragm, and not below, to form the *left* or the proper thoracic *canal*. The chyliferous vessels frequently do not form a trunk, but open into this canal very near each other, and nine or ten in number. Most generally, however, the thoracic canal is formed by three trunks, a right, a central, and a left trunk. The first arises by the union of the lacteal vessels; the other two are formed by the lymphatic vessels of the lower extremities. The right and the central are situated on the right side, and the left on the left side of the aorta. The first two unite before the third joins them. The latter sometimes unites to the principal trunk only by small branches.

§ 1700. The ancient anatomists admitted at the union of these vessels, and consequently at the commencement of the thoracic canal, a dilatation called the *reservoir* or *cistern of Pecquet* (*receptaculum*, s. *cysterna chyli*). This dilatation, however, is often very much contracted, and its apparent existence depends on the manner in which the lacteal vessels arrive at the thoracic canal. In fact they turn upon it, are enveloped by a common cellular sheath, and united by cellular tissue: when this sheath and this tissue are raised, the pretended reservoir almost always disappears.

In some subjects, however, the thoracic canal presents in this place a considerable dilatation, a kind of reservoir.

§ 1701. The thoracic canal passes into the chest behind the aorta, and on the right of it, between the internal pillars of the diaphragm. It is at first placed in the centre of the dorsal vertebræ, rather more to the right than to the left, between the aorta and the azygos vein, a little however before the latter, and directly behind the right layer of the posterior mediastinum. In ascending it goes to the left, but does not always preserve the same situation, although it is placed from the third to the sixth dorsal vertebra behind the esophagus, and is covered by this canal in a greater or less extent. After leaving the third dorsal vertebra, it ascends at the side of the esophagus, and passing behind the arch of the aorta, leaves the chest to extend to the upper edge of the last cervical vertebra. Thence it goes downward and forward, which much favours the progress of the chyle, and in most subjects it empties itself at the angle of union of the left subclavian and internal jugular vein, usually by one trunk, rarely by several. It rarely opens into one of these two veins.

§ 1702. It is always a little narrower at the middle dorsal vertebra, but below this point again dilates more or less, as it receives the superior and pulmonary intercostal lymphatic vessels. It presents in its course no projections, but describes greater or less curves, and it does not receive many lymphatic vessels, except towards its upper extremity where the trunks of the left half of the head and of the left upper extremity open into it directly before it joins the venous system.

It is rarely or never perfectly single; being always attended with a

greater or less number of accessory branches, which open into it, and immediately arise again from its parietes.

It very frequently divides, especially a little above the centre of the chest, into two, and sometimes into three branches, which almost always reunite after proceeding a greater or less distance. Sometimes it divides in this manner in more than one place ; the accessory vessels enlarge more or less, and assume the characters of real trunks. When this reticulated structure exists in the greatest degree, the whole of the thoracic canal is divided into two halves.*

§ 1703. The valves in this canal are not numerous, either near its origin, or near its termination. One pair exists above and opposite the upper dorsal vertebra. Higher up they are double or triple. The convex edge of these valves is turned downward, and their loose or concave edge upward. They are generally arranged in pairs, and rarely three and three, or singly.

We almost always observe, where the thoracic canal opens into the venous system, before its mouth, two very perfect valves, the loose edges of which are turned toward the cavity of the vein, and prevent the reflux of the blood into the canal. They are sometimes concealed by the valves of the internal jugular vein, so that some have pretended, but very unfortunately, that they were unconnected with the thoracic canal, because that they are farther from the heart than the orifice of the canal.†

II. RIGHT THORACIC CANAL.

§ 1704. The *right thoracic canal*, the formation of which we have already mentioned, is much smaller than the preceding (§ 1698), and is usually only an inch long. It descends to empty into the angle of union of the right internal jugular and subclavian veins, rarely into one of these two vessels. Sometimes it does not exist ; this occurs when the vessels which give origin to it open separately into the venous system.

§ 1705. There are always considerable anastomoses, not only between the vessels which unite to form the two common trunks, but also between these trunks.

The insertion of the large thoracic canal in the right half of the venous system‡ is undoubtedly only a greater development of these anastomoses, in accordance with the same law by which analogous phenomena are seen also in other parts of the vascular system ; for instance, the origin of the arteries of the fore-arm above the usual point, and that of the obturator artery by a trunk in common with the epigastric artery. This anomaly is indicated also by the division of the thoracic canal into two halves, which we have already mentioned (§ 1701).

* Sœmmerring, *loc. cit.* p. 487.
† Portal. *loc. cit.*, p. 389.
‡ Meckel, *Ep. ad Hallerum*, p. 30.—Cruikshank, in Ludwig, p. 152.

When the great thoracic canal empties into the right side of the venous system, the lymphatics of the left half of the head, the neck, the arm, the lung, the heart, &c., do not join, but are arranged like the corresponding lymphatic vessels of the right side in the normal state.

Thus when we consider the gradual development of this anomaly, we see in it the first degree of lateral inversion.*

The insertion of the large thoracic canal, which takes place on the left side in the normal state, seems to depend on an effort to re-establish the symmetry which is deranged by the distribution of the venous trunks on the right side.

SECTION VII.

A COMPARISON OF THE DIFFERENT REGIONS OF THE VASCULAR SYSTEM.

§ 1706. According to a law established in our introduction, there is an analogy but not a perfect resemblance between the different parts of the vascular system, in respect to its three dimensions, that is, from right to left, from above downward, and from before backward.

§ 1707. In accordance with the same law, the most marked analogy is that between the right and the left half of the system, which differ but slightly. Except inconstant variations, the only one of consequence is that in the arrangement of the trunks given off to the head and the upper extremities by the arch of the aorta (§ 1335). This difference seems to be only a part of a general type, which exists in all the arterial system. At least, the right superior aortic intercostal artery and the bronchial artery of the same side usually arise by a common trunk (§ 1439), even as in anomalies, several vessels of the right side often unite in a single trunk, while on the left side one trunk divides into several. Thus, for instance, the left carotid artery not unfrequently arises from the innominata, although the left vertebral artery often comes from the aorta: so too the left renal artery divides into several trunks more frequently than the right. In the single instance we have seen of the high division of the brachial artery on one side only, this was the left. This side also is the only one where we once observed an uncommonly high division of the popliteal artery. The obturator artery arises from the crural artery on the left side more frequently than on the right. When the innominata is divided at the arch of the aorta into its two trunks, the right subclavian artery rarely remains on the right: it goes to the left, and arises more on the left of the aorta; so that in fact this anomaly seems to depend

* See our *Handbuch der path. Anatomie*, vol. ii. part 1, p. 183.

primitively on an extraordinary development of the left side and to the predominance of its type over that of the right side; this opinion is strongly favoured by the fact that in cases of this nature the right subclavian artery no longer takes the shortest course to arrive at its limb, but turns aside, passing behind the esophagus.

The special characters of the two extremities are often unusually developed simultaneously. Thus, for instance, the left carotid artery is a branch of the innominata, at the same time that the left vertebral artery arises directly from the aorta; on the right and left carotid arteries are united in a single trunk, when the right subclavian artery arises below the left.

The contrary seems to be the case with the venous and lymphatic systems; for the left subclavian and common iliac veins are much longer than the synonymous trunks on the right side, and the superior and inferior thoracic canals of the left side unite, while the right superior proceeds alone.

Finally, the arrangement not unfrequently becomes unusually symmetrical, either by the union or the divisions of the trunks, or because a trunk which is generally placed on the right or the left proceeds on the median line.

§ 1708. Although the upper and the lower halves of the vascular system are less similar than the right and the left, the analogies between them much exceed their differences.

The diaphragm separates the upper from the lower half of the vascular system. If we compare these two halves with each other, after leaving this muscular septum, we obtain the following results:

1st. In the chest, as in the abdomen, the large circulatory system comprises two, which are smaller, viz. the pulmonary circulation in the thorax and that of the vena portæ in the abdomen. The trunk of the vena portæ is an imperfect repetition of the right half of the heart: its arterial portion represents the pulmonary arteries, and the hepatic veins correspond to the pulmonary veins. The system of the vena portæ is a very imperfect imitation of the pulmonary system, because no muscular heart is there developed, and because the veins open into the general venous system. These are however two conditions, which alone or united occur in the system of the pulmonary vessels of most animals which have blood-vessels, and which are below the class of birds.

2nd. The upper and the lower halves of the arterial system are repetitions of each other in the following respects:

a. The superior and inferior diaphragmatic arteries correspond.

b. The esophageal arteries, the celiac, and the two mesenteric arteries correspond by large anastomoses.

c. The bronchial arteries are represented by a part of the renal and capsular arteries, and by the hepatic. In fact we may consider the liver, the renal capsules, and the kidneys, as analogous to the lungs, whence the vessels of these organs are repetitions of those of the lungs in different degrees of perfection. The vascular system of the liver

resembles that of the lungs, as it includes the different arteries of the system of the vena-porta ; but it is less perfect. The renal and capsular vessels are still lower in the scale, for there we cannot trace the separation between the vessels of nutrition and those of secretion ; this separation is indicated in the kidneys by some vessels different from the renal arteries, which are distributed on the surface of these organs and in the renal capsules, by numerous vascular ramifications, which come from very different regions.

d. The thymic arteries correspond to the spermatic arteries, as both generally arise from the trunk of the aorta, and the former frequently come from the bronchial arteries and the latter from the renal arteries.

e. The aortic intercostal arteries are represented by the lumbar arteries. In fact the latter are fewer; but as the branches which arise from the middle sacral artery, a continuation of the trunk of the aorta, present the same arrangement as they, every difference in this respect disappears. The analogy remarked between the arteries which pass through the intervertebral foramina, above and below the diaphragm , is evidently strengthened by the fact that the superior intercostal artery is a branch of the subclavian (§ 1399), as the lateral sacral artery is one of the hypogastric artery.

f. The division of the upper and lower extremities of the aorta, and the arrangement of the vessels which arise from it on one side to go to the neck, the head, and the upper extremities, on the other to the organs of the pelvis and to the lower extremities, present a most striking analogy. The primitive iliac artery corresponds to the common trunk of the right subclavian and carotid arteries. It is true the analogy does not exist on the left side, but notwithstanding this difference is not essential, as it depends on a consecutive division, the analogy between the two regions is increased by the origin of the left vertebral artery directly from the arch of the aorta, between the left carotid and subclavian arteries, which is common, since this anomaly causes, in some measure, the union of the two vessels.

The carotid correspond to the hypogastric arteries, and the subclavian to the crural arteries, in respect to situation, origin, and distribution.

Of the trunks which arise from the carotid and the hypogastric arteries the superior thyroid and its branches correspond to the uterine and the vesical arteries, the facial and the ascending pharyngeal to the internal pudic and to its branches.

The differences in this respect are as follows :

The subclavian artery gives origin to the vertebral and the inferior thyroid artery; the hypogastric to the gluteal and ischiatic artery. These latter are distributed like the branches of the subclavian and even of the axillary arteries. The former seem, at first view, to have none which correspond to them in the inferior vascular system, or to correspond to the vessels which arise from the hypogastric artery.

This difference almost disappears when the thing is examined attentively.

We cannot in fact deny that the vertebral and the inferior thyroid artery do not properly correspond to the hypogastric artery. The carotid arteries represent only a small part of the latter, which is much developed and reduced to a considerable trunk on account of the greater size of the parts it nourishes. The hypogastric artery is then divided in the upper part of the body into three trunks, the carotid, the vertebral, and the inferior thyroid artery. Hence why the inferior thyroid artery so often wholly or in great part arises from the carotid or the innominata artery, or is entirely deficient, or is replaced by the branches of the superior. The origin of most of the vessels of the neck and of the upper region of the shoulder from the inferior thyroid artery also favours this analogy very much, as these vessels are very similar to the gluteal, the ischiatic, and the obturator arteries.

The vertebral artery is ranked as a distinct trunk because of the size of the brain and the spinal marrow, organs to which it carries blood; but it evidently corresponds in its mode of distribution to the lateral sacral arteries furnished by the hypogastric artery.

Many vessels which correspond in their distribution arise above from the subclavian, and below from the hypogastric artery.

The branches which arise directly from the subclavian and from the crural artery are very analogous. The internal mammary artery exactly resembles the epigastric artery, as the first proceeds on the sides of the posterior face of the sternum, and the second backward and on the sides of the linea alba which corresponds to this bone. The anterior intercostal arteries, given off by the internal mammary artery, are represented by the analogous branches of the epigastric artery.

The circumflex iliac artery seems to us to correspond exactly to the long external thoracic artery (§ 1405).

The external pudic arteries manifestly represent several external thoracic arteries.

In both extremities the trunk of the artery divides a short distance above the first articulation into a superficial vessel, which descends to the extremity of the limb, and into a deep vessel, which does not extend beyond the first articulation, that is, beyond the arm or the thigh.

The two circumflex arteries arise very high, sometimes from the superficial and sometimes from the deep trunk. They evidently correspond in their relations with the bone and the first articulation of the extremity, although they slightly differ in their distribution, as those of the arm are expanded in the superficial, and the femoral in the deep muscles, and also as one of the circumflex arteries of the arm is generally much smaller than its corresponding one in the thigh. This latter circumstance depends upon the greater development of the muscles of the thigh. The first depends upon the fact that the highest

branches, arising from the hypogastric artery, are distributed to the muscles corresponding to those of the arm, which receive the blood from the circumflex arteries.

The superficial brachial artery divides like the crural, at the second articulation, into two trunks, one of which soon bifurcates in a similar manner. The anterior tibial corresponds to the radial artery, the posterior to the ulnar, and the peroneal to the interosseous artery.

The division of these vessels however differs remarkably, as it frequently occurs unusually high in the upper extremity, while this anomaly is very rare in the lower extremity, as is proved by our numerous observations and those of other anatomists.

It is difficult to assign the cause of this difference. The most probable explanation is that it depends upon the fact that the upper limbs form and are developed sooner than the lower, and are nearer the heart. Perhaps it depends partly on the greater length of the fingers, the volume of which, compared to that of the posterior part of the hand, much exceeds that of the toes, compared with the posterior part of the foot, and hence they always appear long before the latter. This anomaly, which is almost peculiar to the arteries of the upper extremities, would consequently arise from the normal arrangement with these latter; to support which conjecture, we would mention the analogous difference in the arrangements of the muscles of the fingers and toes, since the hand presents no trace of the short flexor and extensor of these appendages of the foot. We even recognise with a little attention, that all the upper part of the vascular system differs thus from the lower; for the separation of the carotid with the vertebral and inferior thyroid arteries, the constant separation of the carotid with the subclavian artery on the left side, the frequent origin of the vertebral artery with the latter, and the not unfrequent existence of a second inferior thyroid artery, (§ 1395) are analogous phenomena, of which we find no trace in the lower extremities.

Thus the vascular system of the upper part of the body is characterized by a tendency to divide. But it is not the only part where this tendency is remarked, since it is observed in the development of the brain, the multiplication of the organs of the senses, and the perfection of the extremities, which are perhaps the cause and condition of it.

The arteries of the lower extremities have entirely opposite characters. The circumflex arteries of the thigh are given off by the deep crural artery, more frequently than those of the arm are by the deep brachial. The superficial crural artery seldom divides higher than usual, and the number of branches given off by the popliteal artery is frequently less, because the peroneal or the anterior tibial, the first much more frequently and to a greater degree than the second, ceases to form a distinct trunk, and is replaced by the branches of the other vessels of the leg, precisely as the fibula is in some measure only an appendage of the tibia, while in the fore-arm the radius and ulnar are also developed, and both articulate with the humerus, and exactly also

as the toes are developed much more imperfectly, and much less movably than the fingers.

The articular arteries of the elbow and of the knee differ principally,

1st. Because the upper vessels of the thoracic extremity arise higher, and are always separated from the others, while those of the pelvic extremity are situated lower, and usually arise by a common trunk.

2nd. Because the inferior arteries of the pectoral limbs arise from the arteries of the fore-arm, and those of the abdominal members from the lower part of the popliteal artery. The internal and superior popliteal artery not unfrequently arises very high ; there are always two smaller inferior articular popliteal arteries which arise from the anterior and posterior tibial arteries, and not very unfrequently the recurrent radial artery is given off by the brachial artery. When the popliteal artery divides a little higher than usual, its two branches furnish also the two largest inferior articular arteries of the knee.

Many anatomists mention as a difference in the distribution of the arteries of the hand and foot, the want of a superficial arch in the latter. We have never found this assertion to be correct, and it certainly depends upon a want of care in searching into the analogies. In fact the internal plantar artery doubtless corresponds in its origin and course to the superficial palmar branch of the ulnar artery. Besides, we have always known it to anastomose with the plantar branch of the anterior tibial artery, so as to form a superficial plantar arch.

But there is a real difference between the origin of the arteries of the fingers and toes, inasmuch as the former arise from the superficial, and the latter from the deep arch. This deviation of the vessels on the surface of the sole of the foot, is sometimes developed to such an extent, that the arteries of the toes come from the superior rather than from the inferior perforating arteries (§ 1530). This arrangement appears to be intended to prevent the compression of the arteries of the toes by the weight of the body. Perhaps also it depends on the difference between the back and the palm of the hand, as also between the back and the sole of the foot, in regard to muscularity ; and perhaps the development, on the back of the foot, of the muscles which do not exist on that of the hand, is the reason that the arteries of the toes arise more deeply. Finally, this difference sometimes disappears, since in some subjects the arteries of the fingers are given off by the superficial palmar arch.

3rd. The veins of the upper and lower portion are perhaps more similar than the arteries, at least the arteries present a difference which does not exist in the arrangement of the left jugular and subclavian veins, and that of the left primitive iliac vein.

4th. The upper and lower portions of the lymphatic system, also present the same analogies in respect to the existence, the number, and the situation of the vessels and of the glands.

§ 1709. In the vascular system as in the rest of the organism, the analogy is not so great forward and backward, as from right to left, and from above downward. We may, however, in this direction, com-

pare the internal mammary and the epigastric arteries to the aorta, and its branches to the posterior intercostal and the lumbar arteries So, too, there is a correspondence between the anterior and the posterior branches of the anterior and posterior intercostal arteries and of the lumbar arteries : perhaps in the neck and in the head, between the superficial and the deep arteries, certainly in these two regions, and in the spinal marrow, between the anterior and the posterior spinal, and also between the occipital and the frontal arteries ; finally in the limbs between the anterior and posterior circumflex arteries of the humerus, the external and internal circumflex arteries of the femur, the superficial and the deep brachial and the crural arteries, the radial and the ulnar, and the anterior and the posterior tibial arteries, the dorsal arches of the back of the hand and of the foot, and the superior interosseous arteries of the plantar and palmar arches.

The venous system presents the same analogies, which are rendered still more striking by the existence of an azygos and of a semi-azygos vein, which correspond very evidently to the internal mammary veins.

We may compare with the large thoracic canal, which proceeds before the vertebral column, a second lymphatic duct, which ascends behind the sternum.

INDEX TO VOLUME I.

PAGE

Sources. i
PART I. General remarks on the human body . . 1
PART II. Topography of the organic systems . . . 11
BOOK I. Osteology 11
Section I. Bones of the trunk 13
Chapter I. Of the vertebral column . . . 13
Art. i. General remarks on the primitive bones . . 13
1. General characters of the vertebræ . . 14
2. Development 15
3. Sexual differences 16
Art. ii. Differences between true and false vertebræ . 16
Art. iii. Particulars of the true vertebræ . . 17
Art. iv. Special characters on some of the true vertebræ . 20
A. Normal state 20
I. First cervical vertebra 20
II. Second cervical vertebra . . . 21
III. Seventh cervical vertebra . . . 22
B. Development 23
Art. v. False vertebræ 26
I. Sacrum 26
II. Coccyx 29
Art. vi. Vertebral column in the abnormal state . . 30
1. Primitive anomalies 30
2. Accidental deviations of formation . . 32
Chap. II. Of the accessory bones of the trunk . . . 33
I. Sternum 33
A. Normal state 33
a. Perfect state 34
b. Development 35
B. Abnormal state 37
II. Ribs 38
A. Normal state 38
I. Perfect state 38
a. General characters of the ribs . . 38
b. Differences of the ribs . . . 39

II. Development 41
III. Sexual differences 41
B. Abnormal state 41
Section II. Of the bones of the head . . . 41
A. Normal state 41
Chap. I. Of the skull 45
A. Individual bones 45
I. Basilar bone 45
a. Occipital bone 46
b. Sphenoid bone 49
II. Temporal bones 55
III. Parietal bones 59
IV. Frontal bone 60
V. Ethmoid bone 62
Chap. II. Of the bones of the face . . . 64
I. Upper maxillary bones 64
II. Palate bones 68
III. Malar bones 70
IV. Nasal bones 71
V. Unguiform bones 71
VI. Inferior turbinated bones 72
VII. Vomer 73
VIII. Lower maxillary bones 73
IX. Hyoid bone 76
1. Central hyoid 76
2. Inferior hyoid 77
3. Superior hyoid 77
Chap. III. General remarks on the bones of the head . 78
I. General form of the head 78
1. Orbits 81
2. Nasal fossæ 82
3. Oral cavity 85
4. Temporal fossa 86
II. Comparison of the bones of the head with each other and with the other bones 86
Chap. IV. On the anomalies of the bones of the head . 94
I. Congenital deviations of formation . . . 94
1. Absence and smallness 95
2. Separation of the bones of the head . . . 95
III. Abnormal union of bones of the head . . 99
Section III. Of the bones of the extremities . . . 100
Chap. I. Bones of the upper extremities . . . 101
Art. i. Bones of the shoulder 101
1. Scapula 101
2. Clavicle 103
Art. ii. Humerus 105
A. Normal state 105
B. Abnormal state 107

Art. III. Bones of the fore-arm 107
A. Normal state 107
1. Ulna 107
2. Radius 109
B. Anomalies 110
Art. IV. Bones of the hand 111
A. Normal state 111
I. Bones of the wrist 111
I. First carpal range 111
1. Scaphoid bone 111
2. Semilunar bone 112
3. Pyramidal bone 112
4. Pisiform bone 113
II. Second carpal range 113
1. Trapezium 113
2. Trapezoides 113
3. Os magnum 114
4. Os unciforme 114
II. Metacarpal bones 115
I. First metacarpal bone 116
II. Second metacarpal bone 117
III. Third metacarpal bone 117
IV. Fourth metacarpal bone 117
V. Fifth metacarpal bone 118
III. Bones of the fingers 118
I. Phalanges of the first range 118
II. Phalanges of the second range 119
III. Phalanges of the third range 119
B. Anomalies of the bones of the hand . . . 119
Chap. II. Of the bones of the lower extremities . . 120
Art. I. Iliac bones 120
A. General remarks on the iliac bones . . . 120
I. Ilium 120
II. Ischium 121
III. Pubis 122
B. The iliac bones articulated, or, of the pelvis . . 124
I. Normal state 124
II. Anomalies 128
Art. II. Femur 130
Art. III. Bones of the leg 132
I. Tibia 132
II. Fibula 134
III. Patella 135
Art. IV. Bones of the foot 136
I. Tarsus 136
I. Bones of the posterior tarsal range . . . 136
1. Astragalus 136
2. Os calcis 137

II. Bones of the anterior tarsal range . . . 139
1. Scaphoid bone 139
2. Cuboid bone 140
3. Cuneiform bones 140
a. First cuneiform bone . . . 141
b. Second cuneiform bone . . . 141
c. Third cuneiform bone . . . 142
II. Metatarsus 142
I. First metatarsal bone 143
2 Second metatarsal bone 144
3. Third metatarsal bone . . . 144
4. Fourth metatarsal bone 145
5. Fifth metatarsal bone . . . 145
III. Bones of the toes 146
1. First phalanx 146
2. Second phalanx 147
3. Third phalanx 147
SECTION IV. Comparison of the bones in the different regions of the body 148

BOOK II. SYNDESMOLOGY 152
SECTION I. Ligaments of the trunk . . . 152
CHAP. I. Ligaments of the vertebral column . . 153
I. Fibrous and fibro-cartilaginous ligaments . . 153
1. Between the bodies of the vertebræ . . 153
A. Anterior vertebral ligament . . . 153
B. Posterior vertebral ligament . . . 154
C. Intervertebral ligaments 155
II. Of the fibrous and fibro-cartilaginous ligaments between the arches and the processes . . . 156
A. yellow ligaments 156
B. Interspinal membranes and superspinal ligaments . 157
a. Interspinal membranes . . . 157
b. Superspinal ligaments 157
c. Intertransverse ligaments . . . 158
II. Capsular ligaments 158
CHAP. II. Of the ligaments of the ribs . . . 158
I. Ligaments between the ribs and the vertebræ . . 158
A. Ligaments of the heads of the ribs . . 158
B. Ligaments of the tubercle and the external transverse ligaments of the ribs 159
C. Internal ligaments of the necks of the ribs . 159
D. Accessory ligaments of the ribs . . . 159
II. Costo-sternal ligaments 159
III. Intercostal ligaments 160
A. Articular ligaments of the costal cartilages . . 160
B. Fibrous ligaments of the costal cartilages . . 160
CHAP III. Of the ligaments of the sternum . . 160

Sect. II. Of the ligaments of the head . . . 161
Chap. I. Of the ligaments between the head and the vertebral column 161
I. Ligaments between the occipital bone and the atlas . 161
1. Anterior occipito-atloidal membrane . . . 162
II. Posterior occipito-atloidal membrane . . . 162
III. Articular ligaments 162
IV. Accessory ligaments 162
II. Ligaments between the basilar bone and the axis . 162
1. Suspensory ligaments of the second cervical vertebra . 163
II. Lateral ligaments of the second cervical vertebra . 163
III. Common ligament between the basilar bone and the cervical vertebræ 163
I. Common internal ligaments 164
A. Crucial ligament 164
B. Ligamentous envelop of the head and cervical vertebræ . 164
II. Common external ligaments 165
IV. Ligament between the first and second cervical vertebræ 165
Chap. II. Ligaments of the lower maxillary bone . . 165
I. Ligaments of the temporo-maxillary articulation . . 165
1. Interarticular cartilage and synovial capsules . 165
A. Interarticular cartilage 165
B. Synovial capsules 166
II. Fibrous ligaments 166
A. External fibrous ligament 166
B. Internal lateral ligament 166
II. Ligament between the skull, the lower maxillary, and the hyoid bones 167
Chap. III. Ligament of the hyoid bones . . . 167
Section III. Ligaments of the extremities . . 168
Chap. I. Ligaments of the upper extremities . . . 168
Art. 1. Ligaments between the trunk and the upper extremities. 168
I. Interclavicular ligament 168
II. Sterno-clavicular articulation 168
A. Interarticular cartilage 169
B. Synovial capsules 169
C. Fibrous ligament 169
III. Costo-clavicular ligament 169
Art. II. Ligaments of the scapula 170
I. Ligaments between the scapula and clavicle . . 170
A. Acromio-clavicular ligament 170
B. Coraco-clavicular ligament 170
II. Proper ligaments of the scapula . . . 171
A. Acromio-coracoid ligament 171
B. Costo-coracoid ligament 171
III. Humero-scapular articulation . . . 172

A. Synovial capsules 172
B. Fibrous capsule 172
Art. iii. Ligaments of the elbow-joint . . . 173
I. Synovial capsule 173
II. Fibrous ligament 173
i. Internal lateral ligament . . . 174
ii. External lateral ligament . . . 174
iii. Anterior and posterior ligament . . 174
Art. iv. Ligaments of the bones of the fore-arm . . 174
I. Superior region 174
i. Annular ligament 174
ii. Round ligament 175
II. Middle region 175
iii. Interosseous ligament . . . 175
III. Inferior region 175
IV. Synovial capsule 175
Art. v. Ligaments between the fore-arm and wrist . 176
I. Synovial capsule 176
II. Interarticular cartilage 176
III. Fibrous ligaments 177
i. Palmar fibrous ligament 177
ii. Dorsal fibrous ligament . . . 177
iii. Anterior fibrous or radial ligament . . 177
iv. Posterior fibrous or ulnar ligament . . 177
Art. vi. Ligaments of the carpal bones . . . 178
I. Between the two ranges . . . 178
i. Synovial capsule 178
ii. Fibrous ligaments 178
iii. Ligaments between the pisiform bone and the anterior range 179
II. Articulation of the carpal bones . . . 179
i. Superior or antibrachial range . . . 179
A. Articulation of the corresponding faces . 179
B. Accessory ligaments 179
ii. Inferior range 179
Art. vii. Ligament of the carpo-metacarpal articulation . 180
I. Synovial capsule 180
II. Fibrous ligaments 180
Art. viii. Articulation of the metacarpal bones with each other 181
I. Synovial capsule 181
II. Fibrous ligaments 181
i. Posterior fibrous ligaments . . . 181
ii. Anterior fibrous ligaments . . . 182
Art. ix. Metacarpo-phalangean and phalangean ligaments . 182
I. Synovial capsules 182
II. Fibrous ligaments 182
i. Lateral ligaments 182

II. Inferior ligament 182
III. Ungual ligament 183
CHAP. II. Ligaments of the inferior extremities . . 183
ART. I. Ligaments of the pelvis . . . 183
I. Fibro-cartilaginous ligaments . . . 184
I. Sacro-iliac symphysis . . . 184
II. Symphysis pubis 184
II. Fibrous ligaments 185
I. Supplementary fibrous ligaments . . . 185
A. Long posterior pelvic ligament . . 185
B. Short posterior pelvic ligament . . . 186
C. Upper anterior pelvic ligament . . 186
D. Lower anterior pelvic ligament . . . 186
II. Proper fibrous ligaments . . . 186
A. Sacro-sciatic ligament . . . 187
B. Small sacro-sciatic ligament . . 187
C. Obturator membrane 187
III. Changes of the pelvic ligaments during pregnancy . 188
ART. II. Ilio-femoral articulation . . . 189
I. Fibro-cartilaginous ligament . . . 189
II. Synovial capsule 189
III. Round ligament 190
IV. Fibrous capsule 190
ART. III. Articulation of the knee . . . 191
I. Synovial membrane 191
II. External fibrous ligaments . . . 192
I. Internal lateral ligament . . . 192
II. Long external lateral ligament . . . 192
III. Short external lateral ligament . . 192
III. Internal fibrous or crucial ligament . . . 192
IV. Semilunar cartilages . . . 192
ART. IV. Articulation of the bones of the leg . . 194
I. Upper articulation 194
II. Middle articulation 194
III. Inferior articulation . . . 195
I. Anterior tibio-peroneal ligament . . . 195
II. Posterior tibio-peroneal ligament . . 195
III. Superior tibio-peroneal ligament . . . 195
ART. V. Articulation of the foot 195
I. Synovial capsule 195
II. Fibrous ligaments 196
I. Anterior ligaments 196
II. Posterior ligaments 196
III. Lateral ligaments 197
A. External lateral ligament . . . 197
B. Internal lateral ligament . . . 197
ART. VI. Ligaments of the tarsus 197
I. Ligaments of the posterior range 197

i. Synovial capsule 197
ii. Fibrous ligaments 198
iii. Ligaments between the anterior and posterior ranges 198
I. Synovial capsules 198
II. Fibrous ligaments 199
A. Calcaneo-scaphoid ligaments . . . 199
B. Astragalo-scaphoid ligaments . . . 199
C. Calcaneo-cuboid ligaments . . . 199
III. Ligaments between the bones of the anterior range . 200
i. Scaphoido-cuboid ligaments . . . 200
ii. Ligaments between the scaphoid and cuneiform bones 200
A. Synovial capsule 200
B. Fibrous ligament 201
iii. Ligaments between the cuboid and cuneiform bones. 201
iv. Ligaments of the cuneiform bones . . 202
Art. vii. Ligaments between the tarsus and metatarsus . 202
I. Synovial capsule 202
II. Fibrous ligaments 203
Art. viii. Ligament of the metatarsal bones and phalanges . 203
I. Metatarsal ligaments 203
i. Posterior ligaments 203
ii. Anterior ligaments 204
II. Ligaments of the toes . . . 204
BOOK III. Myology 205
Sect. I. Muscles of the trunk 206
Chap. I. Muscles of the back 207
Art. i. Muscles of the first superficial or external layer . 208
I. Trapezius 208
II. Latissimus dorsi 209
Art. ii. Muscles of the second layer . . . 210
I. Rhomboidei muscles . . . 210
A. Rhomboideus major . . . 210
B. Rhomboideus minor . . . 210
II. Levator anguli scapulæ 211
III. Serrati muscles 211
A. Serratus posticus superior . . . 212
i. Serratus posticus inferior . . . 212
ii. Splenii muscles 213
A. Splenius colli 213
B. Splenius capitis 213
Art. iii. Muscles of the third layer . . . 214
I. Sacro-spinalis 214
II. Cervicalis descendens . . . 215
III. Biventer cervicis 215
IV. Complexus 215
V. Trachelo-mastoideus . . . 217
VI. Transversalis colli . . . 217

ART. IV. Muscles of the fourth layer . . . 218
I. Dorsal muscles 218
A. Semispinalis colli 218
B. Semispinalis dorsi 218
C. Spinalis dorsi 219
D. Multifidus spinæ 219
E. Interspinales 219
F. Intertransversarii 220
II. Muscles of the fourth layer belonging to the head . 220
A. Posterior recti muscles 221
a. Rectus capitis posticus major . . . 221
b. Rectus capitis posticus minor . . . 221
B. Oblique muscles of the head 221
a. Obliquus capitis inferior 221
b. Obliquus capitis superior 222
C. Rectus capitis lateralis 222
ART. V. Accessory muscles of the fourth layer . . . 223
I. Levatores costarum 223
A. Levatores costarum breves 223
B. Levatores costarum longi 223
II. Scaleni 223
A. Scalenus anticus 224
B. Scalenus medius 224
C. Scalenus posticus 224
D. Supernumerary scaleni 224
III. Quadratus lumborum 225
IV. Intercostales 226
I. Proper intercostales 226
a. Intercostales externi 226
b. Intercostales interni 226
II. Subclavius 227
CHAP. II. Anterior muscles of the trunk . . . 227
ART. I. Abdominal muscles 228
I. Obliquus externus abdominis 228
II. Obliquus internus abdominis 232
III. Transversalis 234
IV. Linea alba 235
V. Rectus abdominis 236
VI. Pyramidalis 238
VII. Diaphragm 238
ART. II. Muscles of the chest 242
I. Pectoralis major 242
II. Pectoralis minor 244
III. Serratus major anticus 244
IV. Triangularis sterni 245
ART. III. Anterior muscles of the neck . . . 245
I. Superficial layer 246
I. Platysma myoides 246
II. Sterno-cleido-mastoideus 247

II. Deep layer 248
i. Rectus capitis anticus major . . . 249
ii. Rectus capitis anticus minor . . . 249
III. Longus colli 249
Art. iv. Sacro-coccygœal muscles . . . 250
Sect. II. Muscles of the head 250
I. Occipito-frontalis 250
II. Muscles of the lower maxillary bone . . . 251
i. Levators of the lower jaw . . . 251
A. Temporalis 252
B. Masseter 252
C. Pterygoideus internus . . . 253
ii. Pterygoideus externus . . . 253
iii. Digastricus 254
Sect. III. Muscles of the extremities . . . 255
Chap. I. Muscles of the upper extremities . . . 355
Art. i. Aponeurotic sheath . . . 255
Art. ii. Muscles of the shoulder . . . 257
I. Deltoides 257
II. Rotators outward 259
i. Supra-spinatus 259
ii. Infra-spinatus 259
iii. Teres minor 259
III. Rotators inward 260
i. Subscapularis 260
ii. Teres major 260
iii. Coraco-brachialis 261
Art. iii. Muscles of the arm . . . 262
I. Triceps extensor 262
II. Biceps flexor 263
III. Brachialis internus . . . 264
Art. iv. Muscles of the fore-arm . . . 265
I. Muscles of the internal face . . . 266
i. Supinator longus 266
ii. Extensor carpi radialis longus . . . 266
iii. Extensor carpi radialis brevis . . . 267
iv. Extensor digitorum communis . . . 267
v. Extensor minimi digiti proprius . . . 269
vi. Extensor carpi ulnaris . . . 269
vii. Anconeus 270
viii. Supinator brevis 270
ix. Abductor pollicis longus . . . 270
x. Extensor pollicis brevis . . . 271
xi. Extensor pollicis longus . . . 271
xii. Extensor indicis proprius . . . 272
II. Muscles of the internal face . . . 273
i. Palmaris longus and brevis, and palmar aponeurosis . 273
ii. Radialis internus 274
iii. Pronator teres 274

IV. Flexor ulnaris 275
V. Flexor digitorum communis sublimis . . 275
VI. Flexor digitorum profundus . . . 276
VII. Ligament of the flexors of the fingers . . 276
VIII. Flexor pollicis longus 278
IX. Pronator quadratus 278
ART. V. Muscles of the hand 278
I. Lumbricales 279
II. Interossei 279
I. Interossei externi 279
II. Interossei interni 280
III. Muscles of the thumb 281
I. Abductor pollicis brevis 281
II. Opponens pollicis 281
III. Flexor pollicis brevis 282
IV. Abductor pollicis 282
IV. Muscles of the little finger . . . 282
I. Abductor minimi digiti . . . 283
II. Flexor minimi digiti 283
III. Adductor minimi digiti . . . 283
CHAP. II. Muscles of the lower extremities . . . 284
ART. I. Aponeurotic sheath 284
I. Tensor vaginæ femoris 285
ART. II. Muscles of the pelvis . . . 286
I. Extensors of the thigh 286
I. Glutæus maximus 286
II. Glutæus medius 287
III. Glutæus minimus 287
II. Rotators outward 287
I. Pyriformis 287
II. Obturator internus 288
III. Gemelli 289
IV. Quadratus femoris 289
V. Obturator externus 289
III. Flexors of the thigh 290
I. Psoas magnus 290
II. Psoas parvus 291
III. Iliacus internus 291
ART. III. Muscles of the thigh 292
I. Adductors 292
I. Pectinæus 292
II. Adductor longus 292
III. Adductor brevis 293
IV. Adductor magnus 293
II. Muscles of the thigh which move the leg . . 294
I. Adductors 294
A. Sartorius 294
B. Gracilis 295
II. Extensors 295

A. Rectus femoris 295
B. Vastus externus 296
C. Vastus internus . . . 297
D. Cruræus 297
E. Subcruralis 298
III. Flexors of the leg 298
I. Internal flexors 298
A. Semitendinosus 299
B. Semimembranosus . . . 299
II. Biceps femoris 300
Art. IV. Muscles of the leg . . . 301
I. Posterior muscles 301
I. Superficial layer 301
A. Triceps cruris 301
B. Plantaris 303
II. Deep layer 303
A. Poplitæus 303
B. Tibialis posticus . . . 304
C. Flexor longus digitorum communis . 304
D. Flexor longus pollicis proprius . . 306
II. External muscles 307
I. Peroneus longus 307
II. Peroneus brevis 308
III. Anterior muscle 309
I. Extensor longus digitorum communis . 309
II. Extensor longus hallucis proprius . . 310
III. Tibialis anticus 311
Art. V. Muscles of the foot 312
I. Muscles of the back of the foot . . 312
I. Extensor communis digitorum brevis . 312
II. Muscles of the sole of the foot . . 313
I. Plantar aponeurosis 313
II. Common muscle of the sole of the foot . 314
a. Flexor digitorum pedis communis brevis . 314
b. Lumbricales 315
c. Interossei 315
a. External interrossei . . 315
b. Internal interossei . . . 316
III. Proper muscles of the toes . . 316
a. Muscles of the great toe . . . 316
a. Abductor hallucis . . . 316
b. Flexor brevis pollicis pedis . . 317
c. Abductor pollicis pedis . . 317
b. Muscles of the little toe . . . 318
a. Abductor minimi digiti . . 318
b. Flexor minimi digiti brevis . . 318
Comparison of the muscles . . . 318
General remarks on the motions of the body . 319
A. Erect posture 319

I. Osseus system 319
i. In the lower extremities . . . 320
ii. In the trunk 320
iii. In the head 320
iv. In the upper limbs 320
II. Ligamentous system 321
III. Muscular system 321
B. Of standing 322
C. Of walking 323
BOOK IV. Angeiology 326
Sect. I. Of the heart 327
Chap. I. General remarks 327
I. Form 327
II. Weight and size 328
III. Situation 328
IV. Texture 329
V. Vessels 332
VI. Nerves 333
VII. Venous portion 335
VIII. Arterial portion 336
IX. Right and left portions . . . 338
Chap. II. Special remarks on the heart . . 341
I. Right auricle 341
II. Right ventricle 344
III. Left auricle 345
IV. Left ventricle 346
V. Septum 347
Chap. III. Pericardium 347
Chap. IV. Differences in the heart from development and sex 348
A. Outer circumference 349
B. Internal arrangement 350
C. Sexual differences 352
Chap. V. Motions of the heart 352
Chap. VI. Abnormal state of the heart . . . 355
Sect. II. Arteries of the body 365
Chap. I. General explanation of the situation of the trunk . 365
Chap. II. Arch of the aorta 367
Art. i. Coronary arteries of the heart . . . 368
Art. ii. Large trunks from the upper part of the arch of the aorta 369
Art. iii. Primitive carotid artery . . . 374
I. External carotid artery . . . 375
A. Anterior branches 376
i. Superior thyroid artery . . . 376
ii. Lingual artery 377
iii. Facial artery 378
B. Inner branch 381
i. Ascending or inferior pharyngœal artery . 381
C. Posterior branches 382

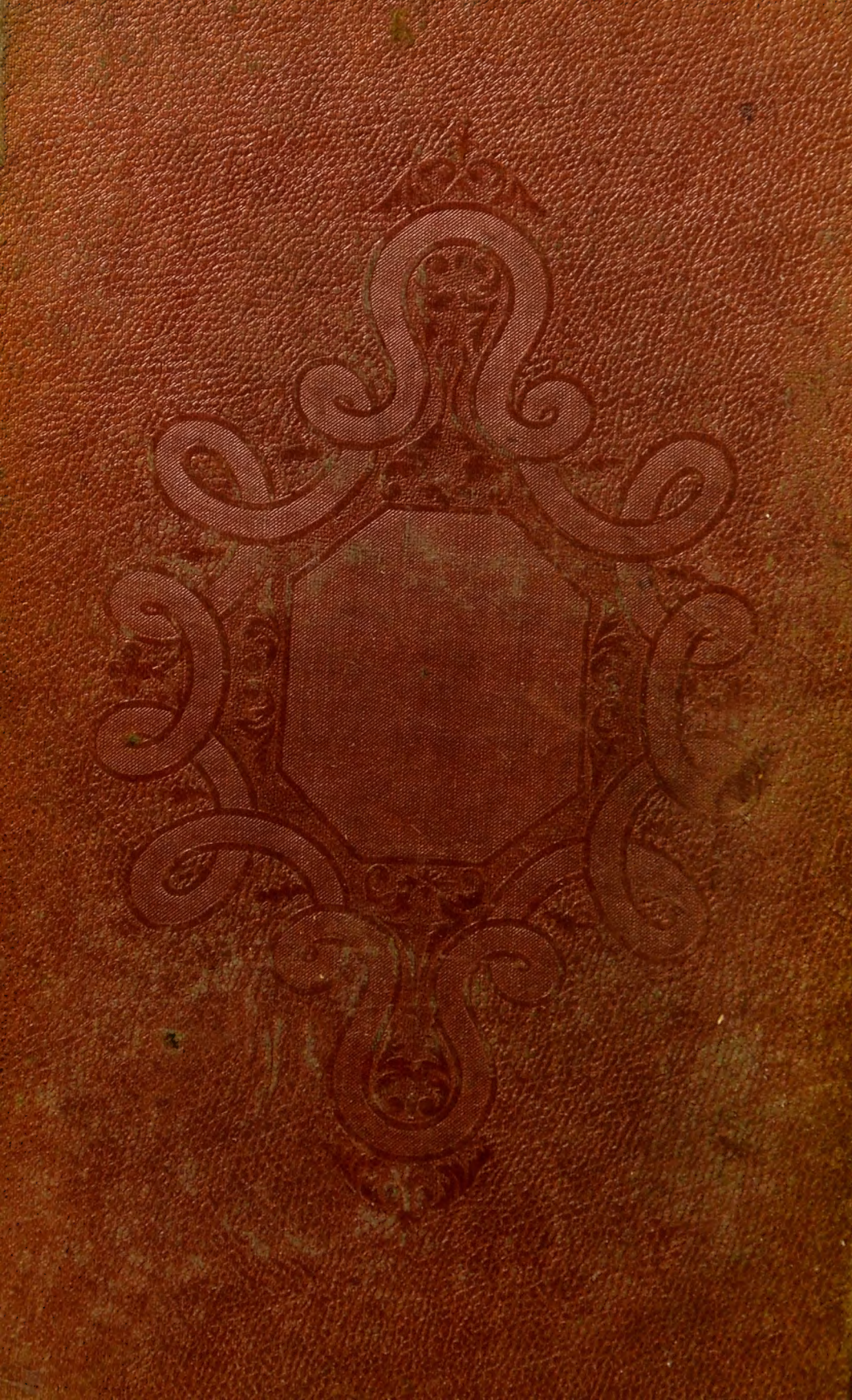
I. Occipital artery 382
II. Posterior auricular artery . . . 383
D. Termination of the external carotid artery . 384
I. Temporal artery 384
II. Internal maxillary artery . . . 385
II. Internal carotid artery 389
I. Ophthalmic artery . . . 393
II. Cerebral arteries 393
ART. IV. Arteries of the upper extremities . . 396
I. Subclavian artery 397
A. Upper posterior branches . . . 398
I. Vertebral artery 398
II. Basilar artery 402
III. Inferior thyroid artery . . . 404
IV. Superior scapular artery . . . 405
V. Transverse cervical artery . . . 405
VI. Ascending cervical artery . . . 406
VII. Lowest thyroid artery . . . 407
VIII. Deep cervical artery . . . 408
B. Inferior branches 408
I. Internal mammary artery . . . 408
II. Superior intercostal artery . . . 410
II. Axillary artery 411
I. External thoracic arteries . . . 412
II. Subscapular artery 413
III. Circumflex arteries of the arm . . 414
a. Anterior circumflex arteries . . 414
b. Posterior circumflex arteries . . 415
III. Brachial artery 416
IV. Arteries of the fore-arm . . . 418
I. Anomalies in their origin . . . 418
II. Radial artery 420
III. Ulnar artery 424
IV. Palmar arches 426
V. Digital arteries 429
CHAP. III. Thoracic aorta 430
A. Anterior branches 430
B. Lateral and posterior branches, intercostal artery . 431
CHAP. IV. Abdominal aorta 434
I. Anterior branches 434
I. Cœliac artery 435
II. Superior mesenteric artery . . . 439
III. Inferior mesenteric artery . . . 442
II. Lateral branches 444
I. Middle capsular arteries . . . 444
II. Renal arteries 444
III. Spermatic arteries 447
III. Posterior branches, lumbar arteries . . 448
CHAP. V. Arteries of the pelvis and lower extremities . 450

I. Middle Sacral artery 450
II. Primitive iliac arteries 451
Art. i. Hypogastric artery 452
I. Ilio-lumbar artery 453
II. Lateral sacral artery 454
III. Obturator artery 454
IV. Gluteal artery 458
V. Ischiatic artery 458
VI. Internal pudic artery 459
VII. Umbilical artery 461
VIII. Vesical arteries 462
IX. Middle hemorrhoidal artery . . . 462
X. Vaginal arteries 463
XI. Uterine arteries 463
Art. ii. External iliac artery 463
I. Epigastric artery 464
II. Circumflex iliac artery 466
Art. iii. Crural artery 467
I. Deep crural artery 468
i. Circumflex arteries 468
ii. Perforating arteries 469
II. Superficial femoral artery . . . 471
III. Popliteal artery 472
Art. iv. Arteries of the leg 475
I. Anterior tibial artery 476
II. Posterior tibial and peroneal artery . . 480
i. Peroneal artery 481
ii. Posterior tibial artery . . . 482
III. Plantar arteries 483
i. Internal plantar artery . . . 483
ii. External plantar artery . . . 483
iii. Plantar arch 484
a. Digital arteries 484
b. Anterior perforating arteries . . 486
c. Posterior perforating arteries . . 486
Sect. III. Veins of the body 487
Chap. I. Veins of the heart 487
I. Large coronary vein 487
II. Small coronary vein 488
III. Small anterior vein 488
IV. Smallest vein 488
Chap. II. Veins of the head and upper extremities . 489
Art. i. Veins of the head 489
I. Superficial veins of the head . . . 489
A. Facial vein 489
I. Supraorbitar vein 490
II. Frontal vein 490
III. Inferior nasal veins 490
IV. Coronary vein of the upper lip . . . 490
V. Internal inferior palpebral vein . . . 491

VI. External inferior palpebral vein . . . 491
VII. Upper anterior maxillary vein . . 491
B. Common temporal vein . . . 492
I. External upper palpebral vein . . . 492
II. External supraorbital vein . . . 492
III. External frontal vein . . . 492
IV. Deep temporal veins 492
V. Superficial temporal vein . . . 493
IV. Trunk of the temporal vein . . . 493
VII. Anterior branches 493
a. Anterior auricular vein . . . 493
b. Transverse facial vein . . . 493
c. Parotid veins 494
VIII. Posterior branches . . . 494
a. Anterior articular veins . . . 494
b. Internal and posterior maxillary vein . 494
IX. Laryngeal vein 494
II. Posterior cephalic vein . . . 494
I. Veins of the brain 494
a. Superior longitudinal sinus . . 495
b. Inferior longitudinal sinus . . 496
c. Right sinus 496
d. Large internal sinus . . . 496
e. Superior veins of the cerebellum . 497
f. Transverse or lateral sinuses . . 497
g. Superior petrous sinus . . . 498
h. Inferior petrous sinus . . . 498
i. Cavernous petrous sinus . . 499
k. Coronary petrous sinus . . . 499
l. Anterior occipital sinus . . . 499
m. Posterior occipital sinus . . . 499
II. Pharyngeal vein 500
III. Lingual vein 500
III. Internal jugular vein . . . 500
I. Superior thyroid vein . . . 501
II. Inferior thyroid vein . . . 501
IV. External jugular vein . . . 501
I. Superior superficial occipital vein . 502
II. Inferior superficial occipital vein . 502
III. Posterior and superior scapular veins . 502
IV. Anterior cutaneous veins . . . 502
ART. II. Veins of the upper extremities . . 502
I. Deep veins 503
II. Superficial veins 503
I. Cutaneous radial vein . . . 503
II. Cutaneous ulnar vein . . . 503
III. Median vein 504
III. Axillary vein 504
IV. Subclavian vein 504

Art. III. Innominata vein 505
I. Vertebral vein 505
II. Sinuses of the vertebral column . . . 506
III. Superior intercostal vein 507
IV. Lowest thyroid vein 507
Chap. III. Superior vena-cava 507
Chap. IV. Azygos vein 508
Chap. V. Veins of the lower extremities . . . 510
I. Deep vein 510
i. Popliteal vein 510
ii. Crural vein 510
iii. Deep crural vein 510
iv Common crural vein 510
II. Superficial veins 511
i. Internal saphena vein 511
ii. External saphena vein 511
iii. External iliac vein 511
iv. Hypogastric vein 512
v. Primitive iliac vein 512
Chap. VI. Ascending vena-cava 512
I. Lumbar veins 514
II. Spermatic veins 514
III. Renal veins 514
IV. Capsular veins 515
V. Hepatic veins 515
VI. Inferior diaphragmatic veins . . . 515
Chap. VII. System of the vena-porta . . . 515
I. Venous portion 516
i. Coronary veins of the stomach . . . 516
ii. Splenic vein 516
iii. Mesenteric vein 516
II. Trunk and arterial portion of the vena-porta . . 517
Sect. IV. Pulmonary artery 517
Sect. V. Pulmonary veins 519
Sect. VI. Lymphatic system 520
Chap. I. Lymphatic glands 521
I. Lymphatic glands of the head and neck . . 521
i. Lymphatic glands of the head . . . 521
ii. Lymphatic glands of the neck . . . 522
II. Lymphatic glands of the upper extremity . . 523
i. Brachial glands 523
ii. Axillary glands 523
iii. Lymphatic glands of the trunk . . . 524
I. Lymphatic glands of the thorax . . . 524
i. Glands of the parietes of the thorax . . 524
ii. Glands of the mediastina 524
iii. Bronchial glands 524
II. Abdominal glands 526

i. Mesenteric glands 526
ii. Gastrœpiploic glands 527
iii. Celiac glands 527
iv. Lumbar glands 527
IV. Lymphatic glands of the lower extremities . . 527
i. Crural glands 528
ii. Pelvic glands 528
I. Inguinal glands 528
II. External iliac glands 528
III. Hypogastric glands 529
IV. Sacral gland 529
Chap. II. Lymphatic vessels 529
Art. i. Lymphatics of the head and neck . . 529
I. Superficial lymphatics 529
II. Deep lymphatics 530
Art. ii. Lymphatics of the upper extremities . . 530
I. Superficial lymphatics 531
i. Of the dorsal face of the trunk . . . 531
ii. Of the lateral and anterior faces of the central region of the trunk 531
iii. Superficial lymphatics of the upper extremities . 531
II. Deep lymphatics of the upper extremities . . 532
III. Termination of the lymphatics . . . 532
Art. iii. Deep lymphatics of the trunk . . 533
I. Lymphatics of the parietes . . . 533
i. Lateral and posterior lymphatics . . . 533
ii. Anterior lymphatics 533
II. Lymphatics of the thoracic viscera . . 534
i. Lymphatics of the lungs 534
ii. Lymphatics of the heart . . . 534
Art. iv. Lymphatics of the lower extremities . . 535
I. Lymphatics of the lower portion of the trunk . 535
II. Lymphatics of the external genital organs . . 535
III. Lymphatic vessels of the lower extremities . 535
i. Superficial lymphatics of the lower extremities . 535
ii. Deep lymphatics 536
Art. v. Abdominal lymphatics 536
I. Lymphatics of the abdominal parietes . . 537
II. Lymphatics of the abdominal viscera . . . 537
i. Deep lymphatics of the genital and urinary organs . 537
ii. Lymphatics of the digestive organs . . 538
I. Lymphatics of the intestinal canal . . 538
II. Lymphatics of the stomach and omenta . . 539
III. Lymphatics of the spleen and pancreas . 539
IV. Lymphatics of the liver . . . 540
a. Superficial lymphatics . . . 540
i. Of its upper face 540
ii. Of its lower face . . . 541
b. Deep lymphatics . . . 541

Art. vi. Thoracic canal 541
I. Left thoracic canal 542
II. Right thoracic canal 544
Sect. VII. Comparison of the different parts of the vascular system 545

LONDON:
J. HENDERSON, 18, BANNER SQUARE.